MOTION IN A STRAIGHT LINE

FACT/DEFINITION TYPE QUESTIONS

1. Which of the following is a one dimensional motion ?
   (a) Landing of an aircraft
   (b) Earth revolving around the sun
   (c) Motion of wheels of a moving train
   (d) Train running on a straight track
2. The numerical ratio of displacement to distance for a moving object is
   (a) always less than 1 (b) always equal to 1
   (c) always more than 1 (d) equal to or less than 1
3. Which of the following can be zero, when a particle is in motion for some time?
   (a) Distance (b) Displacement
   (c) Speed (d) None of these
4. If distance covered by a particle is zero, what can you say about its displacement?
   (a) It may or may not be zero
   (b) It cannot be zero
   (c) It is negative
   (d) It must be zero
5. The location of a particle has changed. What can we say about the displacement and the distance covered by the particle?
   (a) Neither can be zero
   (b) One may be zero
   (c) Both may be zero
   (d) One is +ve, other is –ve
6. The displacement of a body is zero. The distance covered
   (a) is zero
   (b) is not zero
   (c) may or may not be zero
   (d) depends upon the acceleration
7. A body is moving along a straight line path with constant velocity. At an instant of time the distance travelled by it is S and its displacement is D, then
   (a) $D < S$ (b) $D > S$
   (c) $D = S$ (d) $D \leq S$
8. Speed is in general _____ in magnitude than that of the velocity.
   (a) equal (b) greater or equal
   (c) smaller (c) none of these
9. Area under velocity-time curve over a given interval of time represents
   (a) acceleration (b) momentum
   (c) velocity (d) displacement
10. The distance travelled by a body is directly proportional to the time taken. Its speed
    (a) increases (b) decreases
    (c) becomes zero (d) remains constant
11. The slope of velocity-time graph for motion with uniform velocity is equal to
    (a) final velocity (b) initial velocity
    (c) zero (d) none of these
12. The ratio of the numerical values of the average velocity and average speed of a body is
    (a) unity (b) unity or less
    (c) unity or more (d) less than unity
13. The slope of the tangent drawn on position-time graph at any instant is equal to the instantaneous
    (a) acceleration (b) force
    (c) velocity (d) momentum
14. Which of the following is the correct definition for Average speed?
    (a) Average speed $= \dfrac{\text{total displacement}}{\text{total time}}$
    (b) Average speed $= \dfrac{\text{total path length}}{\text{total time}}$
    (c) Average speed $= \dfrac{\text{change in speed}}{\text{total time}}$
    (d) Average speed $= \dfrac{\text{sum of all the speeds}}{\text{total time}}$
15. What is the numerical ratio of velocity to speed of an object ?
    (a) Always equal to one
    (b) Always less than one
    (c) Always greater than one
    (d) Either less than or equal to one.

16. The graph between displacement and time for a particle moving with uniform acceleration is a/an
(a) straight line with a positive slope
(b) parabola
(c) ellipse
(d) straight line parallel to time axis

17. The acceleration of a moving body can be found from
(a) area under velocity - time graph
(b) area under distance -time graph
(c) slope of the velocity- time graph
(d) slope of distance-time graph

18. What determines the nature of the path followed by the particle?
(a) Speed (b) Velocity
(c) Acceleration (d) Both (b) and (c)

19. Acceleration of a particle changes when
(a) direction of velocity changes
(b) magnitude of velocity changes
(c) speed changes
(d) Both (a) and (b)

20. The area under acceleration time graph gives
(a) distance travelled (b) change in acceleration
(c) force acting (d) change in velocity

21. Acceleration is described as rate of change of
(a) distance with time
(b) velocity with distance
(c) velocity with time
(d) distance with velocity

22. Which of the following is the correct expression of instantaneous acceleration ?
(a) $a = \frac{\Delta v}{(\Delta t)^2}$ (b) $a = \frac{dv}{dt}$
(c) $a = \frac{d^2 v}{dt^2}$ (d) $a = \left(\frac{\Delta v}{\Delta t}\right)^2$

23. If a body travels with constant acceleration, which of the following quantities remains constant ?
(a) Displacement (b) Velocity
(c) Time (d) None of these.

24. A body is thrown vertically upwards. If air resistance is to be taken into account, then the time during which the body rises is
(a) equal to the time of fall
(b) less than the time of fall
(c) greater than the time of fall
(d) twice the time of fall

25. Velocity time curve for a body projected vertically upwards is
(a) parabola (b) ellipse
(c) hyperbola (d) straight line

26. A body is thrown upwards and reaches its maximum height. At that position
(a) its acceleration is minimum
(b) its velocity is zero and its acceleration is also zero
(c) its velocity is zero but its acceleration is maximum
(d) its velocity is zero and its acceleration is the acceleration due to gravity.

27. Stopping distance of a moving vehicle is directly proportional to
(a) square of the initial velocity
(b) square of the initial acceleration
(c) the initial velocity
(d) the initial acceleration

28. The path of a particle moving under the influence of a force fixed in magnitude and direction is
(a) straight line (b) circle
(c) parabola (d) ellipse

29. Velocity-time curve for a body projected vertically upwards is
(a) parabola (b) ellipse
(c) hyperbola (d) straight line

30. An object accelerated downward under the influence of force of gravity. The motion of object is said to be
(a) uniform motion
(b) free fall
(c) non uniformly accelerated motion
(d) None of these

31. Choose the wrong statement from the following.
(a) The motion of an object along a straight line is a rectilinear motion
(b) The speed in general is less than the magnitude of the velocity
(c) The slope of the displacement-time graph gives the velocity of the body
(d) The area under the velocity-time graph gives the displacement of the body

32. Free fall of an object (in vacuum) is a case of motion with
(a) uniform velocity
(b) uniform acceleration
(c) variable acceleration
(d) constant momentum

33. A ball thrown vertically upwards after reaching a maximum height h, returns to the starting point after a time of 10 s. Its displacement is
(a) h (b) $2h$
(c) $10h$ (d) zero

34. If the displacement of a body varies as the square of elapsed time, then its
(a) velocity is constant
(b) velocity varies non-uniformly
(c) acceleration is constant
(d) acceleration changes continuously

35. The total distance travelled by the body in the given time is equal to
(a) the area which v– t graph encloses with displacement axis
(b) the area which x – t graph encloses with time axis
(c) the area which v – t graph encloses with time axis
(d) the area which a – t graph encloses with axis

36. Choose the correct equation to determine distance in a straight line for a body with uniform motion.

(a) $s = \frac{v}{t}$ (b) $s = v^2t$

(c) $s = ut + \frac{1}{2}gt^2$ (d) $s = v \times t^2$

37. If the v-t graph is a straight line inclined to the time axis, then

(a) $a = 0$ (b) $a \neq 0$

(c) $a = \text{constant} \neq 0$ (d) $a \neq \text{constant} \neq 0$

38. For a moving body at any instant of time

(a) if the body is not moving, the acceleration is necessarily zero

(b) if the body is slowing, the retardation is negative

(c) if the body is slowing, the distance is negative

(d) if displacement, velocity and acceleration at that instant are known, we can find the displacement at any given time in future.

39. A particle moves 2m east then 4m north then 5 m west. The distance is

(a) 11m (b) 10m

(c) –11m (d) 5m

40. The ball is projected up from ground with speed 30 m/sec. What is the average velocity for time 0 to 4 sec?

(a) 10 m/sec (b) 20 m/sec

(c) 15 m/sec (d) zero

41. A body moves in straight line with velocity v_1 for 1/3rd time and for remaining time with v_2. Find average velocity.

(a) $\frac{v_1}{3} + \frac{2v_2}{3}$ (b) $\frac{v_1}{3} + \frac{v_2}{3}$

(c) $\frac{2v_1}{3} + \frac{v_2}{3}$ (d) $v_1 + \frac{2v_2}{3}$

42. A particle moves in straight line with velocity v_1 and v_2 for time intervals which are in ratio 1:2. Find average velocity.

(a) $\frac{v_1}{3} + \frac{2v_2}{3}$ (b) $\frac{v_1}{3} + \frac{v_2}{3}$

(c) $\frac{2v_1}{3} + \frac{v_2}{3}$ (d) $v_1 + \frac{2v_2}{3}$

43. A particle moves from (2,3) m to (4,1) m. The displacement vector is

(a) $2i + 2j$m (b) $-2i - 2j$m

(c) $2i - 2j$m (d) $-2i + 2j$m

44. If a train travelling at 20 m/s is to be brought to rest in a distance of 200 m, then its retardation should be

(a) 1 m/s^2 (b) 2 m/s^2

(c) 10 m/s^2 (d) 20 m/s^2

45. A body starts from rest and travels 's' m in 2nd second, then acceleration is

(a) 2s m/s^2 (b) 3s m/s^2

(c) $\frac{2}{3}$s m/s^2 (d) $\frac{3}{2}$s m/s^2

46. Two trains, each Xm long are travelling in opposite direction with equal velocity 20 m/s. The time of crossing is

(a) $\frac{X}{40}$s (b) $\frac{X}{20}$s

(c) $\frac{2X}{20}$s (d) Zero

STATEMENT TYPE QUESTIONS

47. Consider the following statements and select the incorrect statements.

I. The magnitude of instantaneous velocity of a particle is equal to its instantaneous speed

II. The magnitude of the average velocity in an interval is equal to its average speed in that interval.

III. It is possible to have a situation in which the speed of the particle is never zero but the average speed in an interval is zero.

IV. It is possible to have a situation in which the speed of particle is zero but the average speed is not zero.

(a) II, III and IV (b) I and II

(c) II and III (d) IV only

48. Select the incorrect statements from the following.

I. Average velocity is path length divided by time interval

II. In general, speed is greater than the magnitude of the velocity.

III. A particle moving in a given direction with a non-zero velocity can have zero speed.

IV. The magnitude of average velocity is equal to the average speed

(a) II and III (b) I and IV

(c) I, III and IV (d) I, II, III and IV

49. The incorrect statement(s) from the following is/are

I. A body having zero velocity will not necessarily have zero acceleration

II. A body having zero velocity will necessarily have zero acceleration

III. A body having uniform speed can have only uniform acceleration

IV. A body having non-uniform velocity will have zero acceleration

(a) II, III and IV (b) I and II

(c) II and III (d) IV only

50. Which of the following statements are correct?

I. A body can have zero velocity and still be accelerated

II. A body can have a constant velocity and still have a varying speed

III. A body can have a constant speed and still have a varying velocity

IV. The direction of the velocity of a body cannot change when its acceleration is constant.

(a) I and II (b) I and III

(c) I, II and III (d) II, III and IV

51. Select the correct statements from the following

I. A body can have constant velocity but variable speed

II. A body can have constant speed but variable velocity

III. A body can have zero velocity but non–zero acceleration

(a) I and II (b) II and III
(c) I and III (d) I, II and III

52. A body is thrown vertically upwards with a velocity u. Select the incorrect statements from the following.

I. Both velocity and acceleration are zero at its highest point

II. Velocity is maximum and acceleration is zero at the highest point.

III. Velocity is maximum and acceleration is g downwards at its highest point.

(a) I and II (b) II and III
(c) I and III (d) I, II and III

53. Which of the following is/are correct statements ?

I. When a body reaches highest point in vertical motion, its velocity becomes zero but acceleration is non -zero.

II. Average velocity of an object is not equal to the instantaneous velocity in uniform motion.

III. Average speed can be zero but average velocity can never be zero

(a) I and II (b) II and III
(c) I and III (d) I, II and III

54. The relative velocity V_{AB} or V_{BA} of two bodies A and B may be

I. greater than velocity of body A

II. greater than velocity of body B

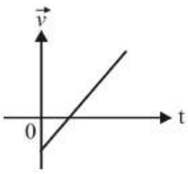
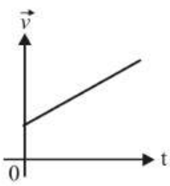
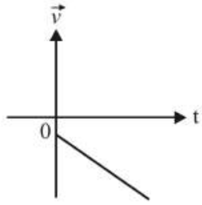
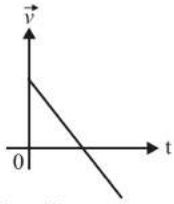
III. less than the velocity of body A

IV. less than the velocity of body B

(a) I and II only (b) III and IV only
(c) I, II and III only (d) I, II, III and IV

MATCHING TYPE QUESTIONS

55. A particle is going along a straight line with constant acceleration a, having initial velocity u. Then match the columns :

Column I	Column II
(A) $u = +$ ve and $a = +$ ve	(1) 
(B) $u = -$ ve, and $a = +$ ve	(2) 
(C) $u = +$ ve, and $a = -$ ve	(3) 
(D) $u = -$ ve, and $a = -$ ve	(4) 

(a) (A)→(3); (B)→(2); C→(1); (D)→(1)
(b) (A)→(2); (B)→(1); C→(4); (D)→(3)
(c) (A)→(1); (B)→(2); C→(3); (D)→(4)
(d) (A)→(4); (B)→(3); C→(2); (D)→(1)

56. For a particle in one dimensional motion, match the following columns :

Column I	Column II
(A) Zero speed but non-zero acceleration.	(1) Body which is about to fall
(B) Zero speed non-zero velocity.	(2) Extreme position of oscillating body
(C) Constant speed non-zero acceleration.	(3) Possible
(D) Positive acceleration must speeding up.	(4) Not possible

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4)
(c) (A)→(1, 2, 3); (B)→(3); C→(4); (D)→(1, 3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

57.

Column I	Column II
(A) Physical quantity whose unit is cm s^{-2} in CGS system	(1) Linear motion
(B) Negative acceleration	(2) Zero
(C) Motion exhibited by body moving in a straight line	(3) Distance
(D) Area under a speed time graph	(4) Acceleration
(E) Velocity of an upward throwing body at the peak point	(5) Retardation

(a) (A)→(4); (B)→(5); C→(1); (D)→(3) ; (E)→(2)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4) ; (E)→(5)
(c) (A)→(5); (B)→(2); C→(3); (D)→(1) ; (E)→(4)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3) ; (E)→(5)

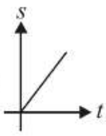
58.

Column I	Column II
(A) Zero acceleration	(1) Retardation
(B) Velocity time graph	(2) Speed
(C) Speed in a direction	(3) Constant motion
(D) Acts in opposite direction of motion	(4) Acceleration
(E) Slope of a distance time graph	(5) Velocity

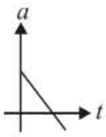
(a) (A)→(4); (B)→(5); C→(1); (D)→(3) ; (E)→(3)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4) ; (E)→(5)
(c) (A)→(5); (B)→(2); C→(3); (D)→(1) ; (E)→(4)
(d) (A)→(3); (B)→(4); C→(5); (D)→(1) ; (E)→(2)

59. **Column I** **Column II**

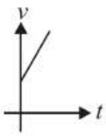
(A) Uniform retardation (1)



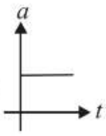
(B) Uniform velocity (2)



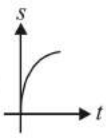
(C) Uniform acceleration with initial velocity (3)



(D) Constant acceleration (4)



(E) Decreasing acceleration at steady rate. (5)



(a) (A)→(2); (B)→(5); C→(1); (D)→(4) ; (E)→(3)
(b) (A)→(5); (B)→(1); C→(3); (D)→(4) ; (E)→(2)
(c) (A)→(5); (B)→(2); C→(3); (D)→(1) ; (E)→(4)
(d) (A)→(3); (B)→(4); C→(5); (D)→(1) ; (E)→(2)

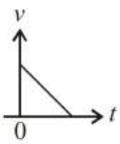
60.

Column I	**Column II**
(A) Velocity	(1) m/s^2
(B) Displacement	(2) vector
(C) Speed	(3) m/s
(D) Acceleration	(4) scalar

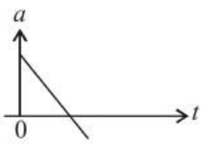
(a) (A)→(2, 3); (B)→(2); C→(3, 4); (D)→(1)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4)
(c) (A)→(1, 2, 3); (B)→(3); C→(4); (D)→(1, 3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

61. **Column I** **Column II**

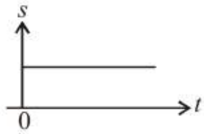
(A) Decreasing acceleration at steady rate (1)



(B) A body at rest (2)

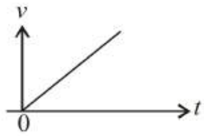


(C) Uniform velocity (3)



(D) Constant motion (4)

(5)



(a) (A)→(2, 3); (B)→(2); C→(3, 4); (D)→(1, 5)
(b) (A)→(1, 2); (B)→(3); C→(5); (D)→(4)
(c) (A)→(1, 2, 3); (B)→(3); C→(4); (D)→(1, 3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

62.

Column I	**Column II**
(A) Distance travelled by a body	(1) zero acceleration
(B) Uniform velocity	(2) $ut + \frac{1}{2}at^2$
(C) Speedometer	(3) instantaneous speed
(D) Height of a vertically thrown body	(4) $\frac{u^2}{2g}$

(a) (A)→(2, 3); (B)→(2); C→(3, 4); (D)→(1, 5)
(b) (A)→(1, 2); (B)→(3); C→(5); (D)→(4)
(c) (A)→(1, 5); (B)→(1); C→(3); (D)→(4, 5)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

63.

Column I	**Column II**
(A) s_n	(1) m/s^2
(B) $v^2 - u^2$	(2) $\frac{u+v}{t}$
(C) Average speed	(3) $2gh$
(D) Acceleration	(4) $u + \frac{a}{2}(2n-1)$

(a) (A)→(4); (B)→(3); C→(2); (D)→(1)
(b) (A)→(4); (B)→(1); C→(2); (D)→(3)
(c) (A)→(3); (B)→(1); C→(4); (D)→(2)
(d) (A)→(2); (B)→(1); C→(3); (D)→(4)

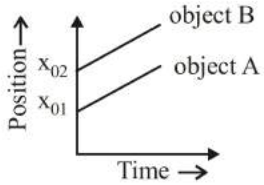
64. Match the Column I and Column II.

Column I	Column II
(A) Displacement	(1) Slope of $x - t$ graph
(B) Velocity	(2) Slope of tangent to x – t Curve
(C) Acceleration	(3) Area under $v - t$ curve
(D) Instantaneous velocity	(4) Slope of $v - t$ graph
	(5) Area. under $x - t$ curve

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(2); (B)→(4); C→(3); (D)→(1)
(c) (A)→(3); (B)→(1); C→(4); (D)→(2)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

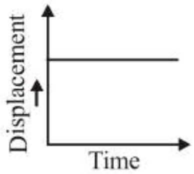
DIAGRAM TYPE QUESTIONS

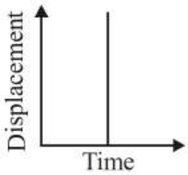
65. The graph shown below represent



(a) A and B are moving with same velocity in opposite directions
(b) velocity of B is more than A in same direction
(c) velocity of A is more than B in same direction
(d) velocity of A and B is equal in same direction

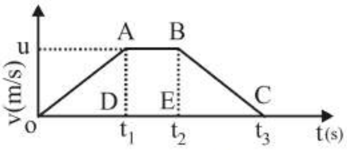
66. Which of the following is not possible for a body in uniform motion?

(a) 

(b) 

(c) Both (a) & (b) (d) None of these

67. The velocity time graph of the motion of the body is as shown below



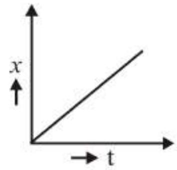
The total distance travelled by the body during the motion is equal to ____.

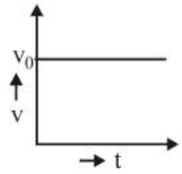
(a) $\frac{1}{2}$ (AD + BE) × OC (b) $\frac{1}{2}$ (OA + BC) × OC

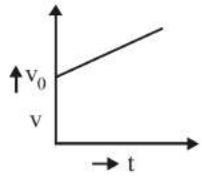
(c) $\frac{1}{2}$ (OC + AB) × AD (d) $\frac{1}{2}$ (OA + AB) × BC

68. Which of the following graphs gives the equation

$x = v_o t + \frac{1}{2} at^2$

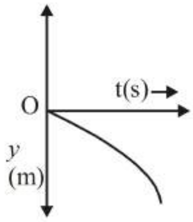
(a) 

(b) 

(c) 

(d) None of these

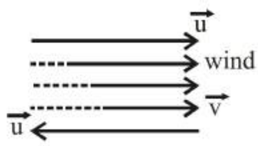
69. The equation represented by the graph below is :



(a) $y = \frac{1}{2} gt$ (b) $y = \frac{-1}{2} gt$

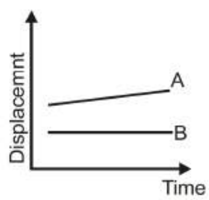
(c) $y = \frac{1}{2} gt^2$ (d) $y = \frac{-1}{2} gt^2$

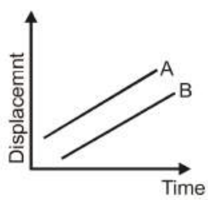
70. Wind is blowing west to east along two parallel tracks. Two trains moving with same speed in opposite directions have the relative velocity w.r.t. wind in the ratio 1 : 2. The speed of each train is

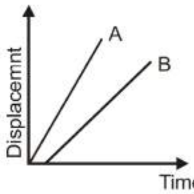


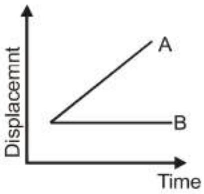
(a) equal to that of wind
(b) double that of wind
(c) three times that of wind
(d) half that of wind

71. Which one of the following represents the time-displacement graph of two objects A and B moving with zero relative speed?

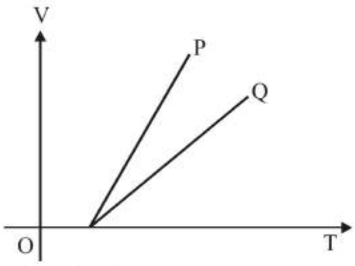
(a) 

(b) 

(c) 

(d) 

72. Figure shows the v-t graph for two particles P and Q. Which of the following statements regarding their relative motion is true ?



Their relative velocity is

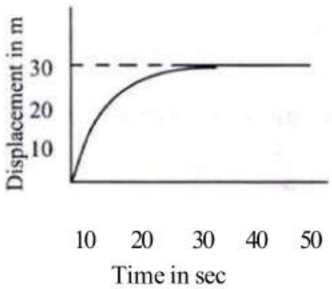
(a) is zero

(b) is non-zero but constant

(c) continuously decreases

(d) continuously increases

73. The displacement of a particle as a function of time is shown in figure. It indicates that



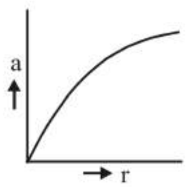
(a) the velocity of the particle is constant throughout

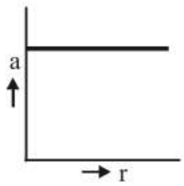
(b) the acceleration of the particle is constant throughout

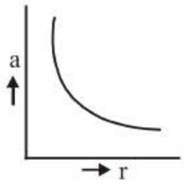
(c) the particle starts with a constant velocity and is accelerated

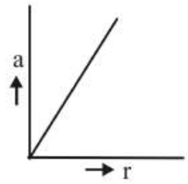
(d) the motion is retarded and finally the particle stops

74. If a body moving in circular path maintains constant speed of 10 ms^{-1}, then which of the following correctly describes relation between acceleration and radius ?

(a) 

(b) 

(c) 

(d) 

ASSERTION- REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct, reason is incorrect

(d) Assertion is incorrect, reason is correct.

75. **Assertion :** Displacement of a body may be zero when distance travelled by it is not zero.

Reason : The displacement is the longest distance between initial and final position.

76. **Assertion :** Displacement of a body is vector sum of the area under velocity– time graph.

Reason : Displacement is a vector quantity.

77. **Assertion :** The position-time graph of a uniform motion, in one dimension of a body cannot have negative slope.

Reason : In one – dimensional motion the position does not reverse, so it cannot have a negative slope.

78. **Assertion :** Position-time graph of a stationary object is a straight line parallel to time axis.

Reason : For a stationary object, position does not change with time.

79. **Assertion :** Velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to the time axis.

Reason : In uniform motion of an object velocity increases as the square of time elapsed.

80. **Assertion:** The average velocity of the object over an interval of time is either smaller than or equal to the average speed of the object over the same interval.

Reason: Velocity is a vector quantity and speed is a scalar quantity.

81. **Assertion :** The speedometer of an automobile measure the average speed of the automobile.

Reason : Average velocity is equal to total displacement per total time taken.

82. **Assertion :** An object can have constant speed but variable velocity.

Reason : Speed is a scalar but velocity is a vector quantity.

83. **Assertion :** The position-time graph of a uniform motion in one dimension of a body can have negative slope.
Reason : When the speed of body decreases with time, the position-time graph of the moving body has negative slope.

84. **Assertion :** position-time graph of a body moving uniformly in a straight line parallel to position axis. Says body is at rest.
Reason : The slope of position-time graph in a uniform motion gives the velocity of an object.

85. **Assertion :** The average and instantaneous velocities have same value in a uniform motion.
Reason : In uniform motion, the velocity of an object increases uniformly.

86. **Assertion :** A body may be accelerated even when it is moving uniformly.
Reason : When direction of motion of the body is changing, the body must have acceleration.

87. **Assertion :** For one dimensional motion the angle between acceleration and velocity must be zero.
Reason : One dimensional motion is always on a straight line.

88. **Assertion :** A particle starting from rest and moving with uniform acceleration travels' a length of x and 3x in first two and next two-seconds.
Reason : Displacement is directly proportional to velocity.

89. **Assertion :** A body is momentarily at rest when it reverses the direction.
Reason : A body cannot have acceleration if its velocity is zero at a given instant of time.

90. **Assertion :** The equation of motion can be applied only if acceleration is along the direction of velocity and is constant.
Reason : If the acceleration of a body is zero then its motion is known as uniform motion.

91. **Assertion :** A positive acceleration of a body can be associated with '*slowing down*' of the body.
Reason : Acceleration is a vector quantity.

92. **Assertion :** The speed of a body can never be negative.
Reason : The speed of an object is the distance travelled by it in unit time and distance can never be negative.

93. **Assertion :** If a passenger stands 'd' aways from a bus and the bus starts moving with a constant acceleration 'a' then the minimum speed of the passenger in order to catch the bus will be $\sqrt{2ad}$
Reason : $v^2 = u^2 + 2ad$,

94. **Assertion :** When brakes are applied to a moving vehicle the distance it travels before stopping is proportional to the square of initial velocity of the vehicle.
Reason : $u^2 = v^2 - 2as$, $\quad s \propto u^2$

95. **Assertion :** In a free fall, weight of a body becomes effectively zero.
Reason : Acceleration due to gravity acting on a body having free fall is zero.

96. **Assertion :** A body falling freely may do so with constant velocity.
Reason : The body falls freely, when acceleration of a body is equal to acceleration due to gravity.

97. **Assertion :** A body, whatever its motion is always at rest in a frame of reference which is fixed to the body itself.
Reason: The relative velocity of a body with respect to itself is zero.

98. **Assertion :** If wind blows west to east and two trains are moving with the same speed in opposite direction and have the stream track of one double than other, then the speed of each train is three times that of the wind.
Reason : If u→ speed of each train and v → speed of wind then $(u + v) = 2(u - v)$ $\quad \therefore u = 3v$

CRITICAL THINKING TYPE QUESTIONS

99. A truck and a car are moving with equal velocity. On applying the brakes both will stop after certain distance, then
(a) truck will cover less distance before rest
(b) car will coverless distance before rest
(c) Both will cover equal distance
(d) None of these

100. If Position of a particle is given by $x = (4t^2 - 8t)$, then which of the following is true?
(a) Acceleration is zero at t = 0
(b) Velocity is zero at t = 0
(c) Velocity is zero at t = 1s
(d) Velocity and acceleration will never be zero

101. A particle located at x=0 at time t=0, starts moving along with the positive x-direction with a velocity 'v' that varies as $v = \alpha\sqrt{x}$. The displacement of the particle varies with time as
(a) t^2 (b) t
(c) $t^{1/2}$ (d) t^3

102. A man leaves his house for a cycle ride. He comes back to his house after half-an-hour after covering a distance of one km. What is his average velocity for the ride ?
(a) zero (b) $2\ \text{km h}^{-1}$
(c) $10\ \text{km s}^{-1}$ (d) $\frac{1}{2}\ \text{km s}^{-1}$

103. A point traversed half of the distance with a velocity v_0. The half of remaining part of the distance was covered with velocity v_1 & second half of remaining part by v_2 velocity. The mean velocity of the point, averaged over the whole time of motion is
(a) $\frac{v_0 + v_1 + v_2}{3}$ (b) $\frac{2v_0 + v_1 + v_2}{3}$
(c) $\frac{v_0 + .2v_1 + 2v_2}{3}$ (d) $\frac{2v_0(v_1 + v_2)}{(2v_0 + v_1 + v_2)}$

104. A particle moves along a straight line OX. At a time *t* (in second) the distance x (in metre) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest?
(a) 24m (b) 40m
(c) 56m (d) 16m

105. A passenger in a moving train tosses a coin. If the coin falls behind him, the train must be moving with

(a) an acceleration (b) a deceleration
(c) a uniform speed (d) any of the above

106. The deceleration experienced by a moving motorboat after its engine is cut off, is given by $dv/dt = -kv^3$ where k is constant. If v_0 is the magnitude of the velocity at cut-off, the magnitude of the velocity at a time t after the cut-off is

(a) $\frac{v_0}{\sqrt{(2v_0^2kt+1)}}$ (c) $v_0 e^{-kt}$
(c) $v_0/2$ (d) v_0

107. A particle moves a distance x in time t according to equation $x=(t+5)^{-1}$. The acceleration of particle is proportional to

(a) $(\text{velocity})^{3/2}$ (b) $(\text{distance})^2$
(c) $(\text{distance})^{-2}$ (d) $(\text{velocity})^{2/3}$

108. A particle is moving eastwards with a velocity of $5\ ms^{-1}$. In 10 seconds the velocity changes to $5\ ms^{-1}$ northwards. The average acceleration in this time is

(a) $\frac{1}{2}ms^{-2}$ towards north
(b) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north - east
(c) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north - west
(d) zero

109. It is given that $t = px^2 + qx$, where x is displacement and t is time. The acceleration of particle at origin is

(a) $-\frac{2p}{q^3}$ (b) $-\frac{2q}{p^3}$ (c) $\frac{2p}{q^3}$ (d) $\frac{2q}{p^3}$

110. An object, moving with a speed of 6.25 m/s, is decelerated at a rate given by: $\frac{dv}{dt} = -2.5\sqrt{v}$ where v is the instantaneous speed. The time taken by the object, to come to rest, would be

(a) 2 s (b) 4 s
(c) 8 s (d) 1 s

111. The position of a particle along the x-axis at certain times is given below

$t(s)$	0	1	2	3
$x(m)$	–2	0	6	16

Which of the following describes the motion correctly?

(a) uniform acceleration
(b) uniform retardation
(c) non-uniform acceleration
(d) there is not enough data for generalization

112. A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t, the maximum velocity acquired by the car is given by

(a) $\left(\frac{\alpha^2+\beta^2}{\alpha\beta}\right)t$ (b) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$
(c) $\left(\frac{\alpha+\beta}{\alpha\beta}\right)t$ (d) $\left(\frac{\alpha\beta}{\alpha+\beta}\right)t$

113. A metro train starts from rest and in 5 s achieves 108 km/h. After that it moves with constant velocity and comes to rest after travelling 45 m with uniform retardation. If total distance travelled is 395 m, find total time of travelling.

(a) 12.2 s (b) 15.3 s
(c) 9 s (d) 17.2 s

114. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15 S , then

(a) $S=\frac{1}{6}ft^2$ (b) $S = ft$
(c) $S=\frac{1}{4}ft^2$ (d) $S=\frac{1}{72}ft^2$

115. A body is projected vertically upwards. If t_1 and t_2 be the times at which it is at height h above the projection while ascending and descending respectively, then h is

(a) $\frac{1}{2}gt_1t_2$ (b) gt_1t_2
(c) $2gt_1t_2$ (d) $2hg$

116. Two balls A and B of same mass are thrown from the top of the building. A thrown upward with velocity v and B, thrown down with velocity v, then

(a) velocity A is more than B at the ground
(b) velocity of B is more than A at the ground
(c) both A &B strike the ground with same velocity
(d) None of these

117. A rocket is fired upward from the earth's surface such that it creates an acceleration of $19.6\ ms^{-2}$. If after 5 s, its engine is switched off, the maximum height of the rocket from earth's surface would be

(a) 980m (b) 735m
(c) 490m (d) 245m

118. A man throws balls with same speed vertically upwards one after the other at an interval of 2 sec. What should be the speed of throw so that more than two balls are in air at any time ?

(a) Only with speed 19.6 m/s
(b) More than 19.6 m/s
(c) At least 9.8 m/s
(d) Any speed less then 19.6 m/s.

119. A ball is dropped from a high rise platform at t = 0 starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at t = 18s. What is the value of v?
(take $g = 10\ m/s^2$)

(a) 75 m/s (b) 55 m/s
(c) 40 m/s (d) 60 m/s

120. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1, h_2 and h_3 is

(a) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$ (b) $h_2 = 3h_1$ and $h_3 = 3h_2$

(c) $h_1 = h_2 = h_3$ (d) $h_1 = 2h_2 = 3h_3$

121. From a building two balls *A* and *B* are thrown such that *A* is thrown upwards and *B* downwards (both vertically). If v_A and v_B are their respective velocities on reaching the ground, then

(a) $v_A > v_B$
(b) $v_A = v_B$
(c) $v_A < v_B$
(d) their velocities depend on their masses.

122. A ball is released from the top of tower of height h metre. It takes T second to reach the ground. What is the position of the ball in T/3 second ?

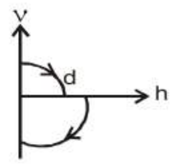
(a) $\frac{h}{9}$ metre from the ground

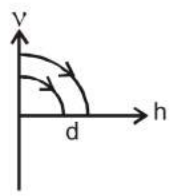
(b) $\frac{7h}{9}$ metre from the ground

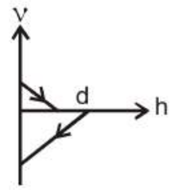
(c) $\frac{8h}{9}$ metre from the ground

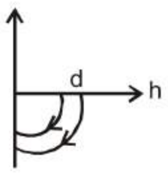
(d) $\frac{17h}{18}$ metre from the ground

123. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height d/2. Neglecting subsequent motion and air resistance, its velocity v varies with the height h above the ground as

(a) 

(b) 

(c) 

(d) 

124. A stone is dropped into a well in which the level of water is h below the top of the well. If v is velocity of sound, the time T after which the splash is heard is given by

(a) $T = 2h/v$ (b) $T = \sqrt{\left(\frac{2h}{g}\right)} + \frac{h}{v}$

(c) $T = \sqrt{\left(\frac{2h}{v}\right)} + \frac{h}{g}$ (d) $T = \sqrt{\left(\frac{h}{2g}\right)} + \frac{2h}{v}$

125. Let A, B, C, D be points on a vertical line such that AB = BC = CD. If a body is released from position A, the times of descent through AB, BC and CD are in the ratio.

(a) $1 : \sqrt{3} - \sqrt{2} : \sqrt{3} + \sqrt{2}$ (b) $1 : \sqrt{2} - 1 : \sqrt{3} - \sqrt{2}$

(c) $1 : \sqrt{2} - 1 : \sqrt{3}$ (d) $1 : \sqrt{2} : \sqrt{3} - 1$

126. Water drops fall at regular intervals from a tab which is hm above the ground. After how many seconds does the first drop reach the ground?

(a) $\sqrt{\frac{2h}{g}}$ (b) $\sqrt{\frac{h}{2g}}$

(c) $\frac{h}{2g}$ (d) $\frac{2h}{g}$

127. If two balls of masses m_1 and $m_2 (m_1 = 2m_2)$ are dropped from the same height, then the ratio of the time taken by them to reach the ground will be

(a) $m_1 : m_2$ (b) $2m_2 : m_1$
(c) 1 : 1 (d) 1 : 2

128. Two cars A and B approach each other at the same speed, then what will be the velocity of A if velocity of B is 8 m/s ?

(a) 16 m/s (b) 8 m/s
(c) – 8 m/s (d) Can't be determined.

129. A train of 150 m length is going towards north direction at a speed of 10 ms^{-1}. A parrot flies at a speed of 5 ms^{-1} towards south direction parallel to the railway track. The time taken by the parrot to cross the train is equal to

(a) 12 s (b) 8 s
(c) 15 s (d) 10 s

130. Two trains are each 50 m long moving parallel towards each other at speeds 10 m/s and 15 m/s respectively. After what time will they pass each other?

(a) $5\sqrt{\frac{2}{3}}$ sec (b) 4 sec

(c) 2 sec (d) 6 sec

131. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to $v(x) = bx^{-2n}$ where b and n are constants and *x* is the position of the particle. The acceleration of the particle as d function of x, is given by

(a) $-2nb^2x^{-4n-1}$ (b) $-2b^2x^{-2n+1}$
(c) $-2nb^2e^{-4n+1}$ (d) $-2nb^2x^{-2n-1}$

132. A ship A is moving Westwards with a speed of 10 km h^{-1} and a ship B 100 km South of A, is moving Northwards with a speed of 10 km h^{-1}. The time after which the distance between them becomes shortest, is

(a) 5 h (b) $5\sqrt{2}$ h

(c) $10\sqrt{2}$ h (d) 0 h

133. From a balloon moving upwards with a velocity of 12 ms^{-1}, a packet is released when it is at a height of 65 m from the ground. The time taken by it to reach the ground is ($g = 10\ ms^{-2}$)

(a) 5 s (b) 8 s
(c) 4 s (d) 7 s

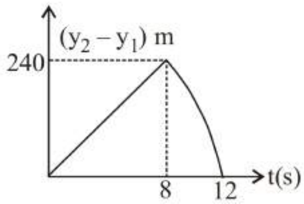
134. A bus is moving with a velocity of 10 ms^{-1} on a straight road. A scootorist wishes to overtake the bus in one minute. If the bus is at a distance of 1.2 km ahead, then the velocity with which he has to chase the bus is

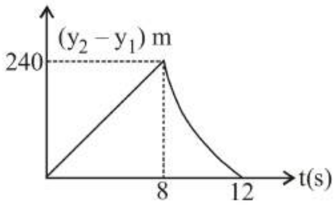
(a) 20 ms^{-1} (b) 25 ms^{-1}
(c) 60 ms^{-1} (d) 30 ms^{-1}

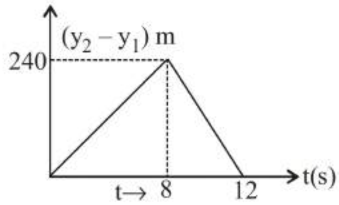
135. A ball dropped from a point A falls down vertically to C, through the midpoint B. The descending time from A to B and that from A to C are in the ratio

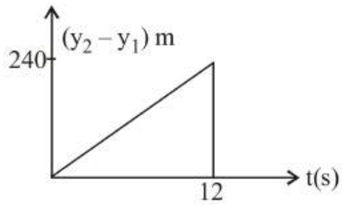
(a) 1 : 1 (b) 1 : 2
(c) 1 : 3 (d) $1:\sqrt{2}$

136. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first ?
(Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10\ m/s^2$)
(*The figures are schematic and not drawn to scale*)

(a)


(b)


(c)


(d)


137. A ball is dropped from the top of a tower of height 100 m and at the same time another ball is projected vertically upwards from ground with a velocity 25 ms^{-1}. Then the distance from the top of the tower, at which the two balls meet is

(a) 68.4m (b) 48.4m
(c) 18.4m (d) 78.4m

138. The ratio of distances traversed in successive intervals of time when a body falls freely under gravity from certain height is

(a) 1:2:3 (b) 1:5:9
(c) 1:3:5 (d) $\sqrt{1}:\sqrt{2}:\sqrt{3}$

139. A particle starting with certain initial velocity and uniform acceleration covers a distance of 12 m in first 3 seconds and a distance of 30 m in next 3 seconds. The initial velocity of the particle is

(a) 3 ms^{-1} (b) 2.5 ms^{-1}
(c) 2 ms^{-1} (d) 1 ms^{-1}

140 . From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle, to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is

(a) $2gH = n^2u^2$ (b) $gH = (n-2\ ^2)u^2d$

(c) $2gH = nu^2(n-2)$ (d) $gH = (n-2\ u)^2$

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. (d) Motion of a body along a straight line is one dimensional motion.

2. (d) $\frac{\text{Displacement}}{\text{distance}} \le 1$

3. (b)

4. (d) Distance covered by a particle is zero only when it is at rest. Therefore, its displacement must be zero.

5. (a) When location of a particle has changed, it must have covered some distance and undergone some displacement.

6. (c)

7. (c) If a body is moving along a straight line path with constant velocity then distance travelled = displacement i.e., D = S

8. (b) In general, in magnitude of speed $\ge$ velocity

9. (d) Area under velocity-time curve represents displacement.

10. (d) When $s \propto t$, so $\frac{s}{t} = \text{constant}$.

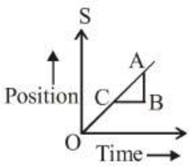
11. (c) The velocity-time graph for a uniform motion is a straight. line parallel to time axis. Its slope is zero.

12. (b)

$$\frac{|\text{Average velocity}|}{|\text{Average speed}|} = \frac{|\text{displacement}|}{|\text{distance}|}$$

because displacement will either be equal or less than distance. It can never be greater than distance travelled.

13. (c) The slope of the tangent drawn on position-time graph at any instant gives instantaneous velocity.

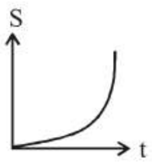


$$AC = \frac{AB}{BC} = V_{inst}$$

14. (b)

15. (d) $\frac{\text{velocity}}{\text{speed}} \le 1$

16. (b) For a particle moving with uniform acceleration the displacement-time graph is a parabola.



17. (c) Slope of velocity-time graph shows acceleration.

18. (d) The nature of the path is decided by the direction of velocity, and the direction of acceleration. The trajectory can be a straight line, circle or a parabola depending on these factors.

19. (c) Because acceleration is a vector quantity.

20. (d) 21. (c) 22. (b) 23. (d)

24. (b) Let the initial velocity of ball be u

Time of rise $t_1 = \frac{u}{g+a}$ and height reached

$$= \frac{u^2}{2(g+a)}$$

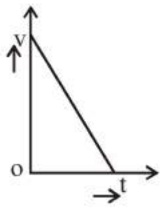
Time of fall t_2 is given by

$$\frac{1}{2}(g-a)t_2^2 = \frac{u^2}{2(g+a)}$$

$$t_2 = \frac{u}{\sqrt{(g+a)(g-a)}} = \frac{u}{(g+a)}\sqrt{\frac{g+a}{g-a}}$$

$\therefore\ t_2 > t_1$ because $\frac{1}{g+a} < \frac{1}{g-a}$

25. (d) Velocity time curve will be a straight line as shown:



At the highest point v = 0.

26. (d)

27. (a) Let s be the distance travelled by the vehicle before it stops.

Final velocity $\upsilon = 0$, initial velocity = u

Using equation of motion $v^2 - u^2 = 2aS$

$0^2 - u^2 = 2aS$

Stopping distance, $S = -\frac{u^2}{2a}$

28. (a)

29. (d) Because acceleration due to gravity is constant so the slope of line will be constant i.e. velocity time curve for a body projected vertically upwards is straight line.

30. (b)

31. (b) The speed in general $\ge$ the magnitude of velocity

32. (b) Free fall of an object (in vacuum) is a case of motion with uniform acceleration.

33. (d) As ball returns to starting point so displacement is zero.

34. (c) As, $s = \frac{1}{2}at^2$

If a is constant, then $s \propto t^2$

35. (c) 36. (c) 37. (c) 38. (d) 39. (a)

40. (a) We should know the displacement in this time.

$\vec{S} = \vec{u}t + \frac{\vec{a}t^2}{2}$ (we take upward as positive)

$S = 30 \times 4 - 10 \times 4 \times \frac{4}{2} = 40\,m.$

The average velocity will be 10 m/sec.

41. (a) $v_{av} = \frac{v_1 t/3 + v_2(2t/3)}{t} = \frac{v_1}{3} + \frac{2v_2}{3}$

42. (a) $v_{av} = \frac{v_1 t/3 + v_2(2t/3)}{t} = \frac{v_1}{3} + \frac{2v_2}{3}$

43. (c)

44. (a) $v^2 - u^2 = 2as \Rightarrow a = \frac{u^2}{2as} = \frac{(20)^2}{2 \times 200} = 1 \text{ m/s}^2$

45. (c) $S_n = u + \frac{a}{2}(2n - 1)$

or, $S = \frac{a}{2}(2 \times 2 - 1) \Rightarrow a = \frac{2}{3}\text{m/s}^2$

46. (a) $\text{Time} = \frac{\text{total length}}{\text{relative velocity}} = \frac{X + X}{20 + 20} = \frac{X}{40}\text{s}$

STATEMENT TYPE QUESTIONS

47. (a) Instantaneous speed is the distance being covered by the particle per unit time at the given instant. It is equal to the magnitude of the instantaneous velocity at the given instant.

48. (c) Average velocity = $\frac{\text{displacement}}{\text{time interval}}$

A particle moving in a given direction with non-zero velocity cannot have zero speed.

In general, average speed is not equal to magnitude of average velocity. However, it can be so if the motion is along a straight line without change in direction.

49. (a) When the body is projected vertically upward then at the highest point its velocity is zero but acceleration is not equal to zero ($g = 9.8\text{m/s}^2$).

50. (b) 51. (b)

52. (d) At highest point $v = 0$ and $H_{max} = \frac{u^2}{2g}$

53. (a) Average velocity can be positive, negative or zero.

54. (d) All options are correct :

(i) When two bodies A & B move in opposite directions then relative velocity between A & B either V_{AB} or V_{BA} both are greater than V_A & V_B.

(ii) When two bodies A & B move in same direction then $V_{AB} = V_A - V_B \Rightarrow V_{AB} < V_A$

$V_{BA} = V_B - V_A \Rightarrow V_{BA} < V_B$

MATCHING TYPE QUESTIONS

55. (b) (A)→(2); (B)→(1); C→(4); (D)→(3)
56. (c) (A)→(1, 2, 3); (B)→(3); C→(4); (D)→(1, 3)
57. (a) (A)→(4); (B)→(5); C→(1); (D)→(3) ; (E)→(2)
58. (d) (A)→(3); (B)→(4); C→(5); (D)→(1) ; (E)→(2)
59. (b) (A)→(5); (B)→(1); C→(3); (D)→(4) ; (E)→(2)
60. (a) (A)→(2, 3); (B)→(2); C→(3, 4); (D)→(1)
61. (b) (A)→(1, 2); (B)→(3); C→(5); (D)→(4)
62. (c) (A)→(2); (B)→(1); C→(3); (D)→(4)
63. (a) (A)→(4); (B)→(3); C→(2); (D)→(1)
64. (c) (A)→(3); (B)→(1); C→(4); (D)→(2)

DIAGRAM TYPE QUESTIONS

65. (d) 66. (c) 67. (c) 68. (c) 69. (d)

70. (c) Let v be velocity of wind and u be velocity of each train.

Rel. vel. of one train w.r.t. wind = 2 × Rel. vel. of other train w.r.t. wind

$u + v = 2(u - v)$

$v + 2v = 2u - u = u.$

i.e., $u = 3v.$

71. (b)

72. (d) The difference in velocities is increasing with time as both of them have different acceleration.

73. (e) From displacement-time graph, it is clear that in equal intervals of time displacements are not equal infact, decreases and after 40s displacement constant i.e. the particle stops.

74. (c) Speed, V = constant (from question)

Centripetal acceleration,

$a = \frac{V^2}{r}$

ra = constant

Hence graph (c) correctly describes relation between acceleration and radius.

ASSERTION- REASON TYPE QUESTIONS

75. (c) The displacement is the shortest distance between initial and final position. When final position of a body coincides with its initial position, displacement is zero, but the distance travelled is not zero.

76. (a) According to definition, displacement = velocity × time. Since displacement is a vector quantity so its value is equal to the vector sum of the area under velocity-time graph.

77. (c)

78. (a) Position-time graph for a stationary object is a straight line parallel to time axis showing that not change in position with time.

79. (c) In uniform motion the object moves with uniform velocity, the magnitude of its velocity at different instance i.e., at $t = 0$, $t = 1$, sec, $t = 2$sec ..... will always be constant. Thus velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to time axis.

80. (a) Because displacement $\leq$ distance and so average velocity $\leq$ average speed.

81. (d) Speedometer measures instantaneous speed of automobile.

82. (a) Since velocity is a vector quantity, hence as its direction changes keeping magnitude constant, velocity is said to be changed. But for constant speed in equal time interval distance travelled should be equal.

83. (c) Negative slope of position time graph represents that the body is moving towards the negative direction and if the slope of the graph decrease with time then it represents the decrease in speed i.e. retardation in motion.

84. (c) If the position-time graph of a body moving uniformly in a straight line parallel to position axis, it means that the position of body is changing at constant time. The statement is abrupt and shows that the velocity of body is infinite.

85. (c) In uniform motion the speed is same at each instant of motion.

86. (a) In uniform circular motion, there is acceleration of constant magnitude.

87. (d) One dimensional motion is always along straight line. But acceleration may be opposite of velocity and so angle between them will be 180°.

88. (c)

89. (c) Assertion is True, Reason is False.

90. (d) Equation of motion can be applied if the acceleration is in opposite direction to that of velocity and uniform motion mean the acceleration is zero.

91. (b) A body having positive acceleration can be associated with slowing down, as time rate of change of velocity decreases, but velocity increases with time.

92. (a) 93. (a) 94. (a) 95. (c)

96. (d) When a body falling freely, only gravitational force acts on it in vertically downward direction. Due to this downward acceleration the velocity of a body increases and will be maximum when the body touches the ground.

97. (a) A body has no relative motion with respect to itself. Hence, if a frame of reference of body is fixed, then the body will be always at relative rest in this frame of reference.

98. (a)

CRITICAL THINKING TYPE QUESTIONS

99. (c) Stopping distance $= \dfrac{\text{kinetic energy}}{\text{retarding force}} = \dfrac{\frac{1}{2}mu^2}{F}$

$$= \frac{u^2}{2\mu g} \qquad [\because F = \mu mg]$$

So both will cover equal distance.

100. (c) Velocity $V = \dfrac{dx}{dt}$

101. (a) $v = \alpha\sqrt{x}$

$$\frac{dx}{dt} = \alpha\sqrt{x}$$

$$\frac{dx}{\sqrt{x}} = \alpha\, dt$$

$$\int_0^x \frac{dx}{\sqrt{x}} = \alpha\int_0^t dt$$

$$\left[\frac{2\sqrt{x}}{1}\right]_0^x = \alpha[t]_0^t$$

$$\Rightarrow 2\sqrt{x} = \alpha t$$

$$\Rightarrow x = \frac{\alpha^2}{4}t^2$$

102. (a) Since displacement is zero.

103. (d) Let the total distance be d. Then for first half distance,

time $= \dfrac{d}{2v_0}$, next distance. $= v_1 t$ and last half distance $= v_2 t$

$$\therefore \; v_1 t + v_2 t = \frac{d}{2}; \quad t = \frac{d}{2(v_1 + v_2)}$$

Now average speed

$$t = \frac{d}{\dfrac{d}{2v_0} + \dfrac{d}{2(v_1+v_2)} + \dfrac{d}{2(v_1+v_2)}}$$

$$= \frac{2v_0(v_1+v_2)}{(v_1+v_2)+2v_0}$$

104. (c) When particle comes to rest,

$$V = 0 = \frac{dx}{dt} = \frac{d}{dt}(40 + 12t - t^3)$$

$$\Rightarrow \quad 12 - 3t^2 = 0$$

$$\Rightarrow \quad t^2 = \frac{12}{3} = 4 \;\; \therefore t = 2 \text{ sec}$$

Therefore distance travelled by particle before coming to rest,

$x = 40 + 12t - t^3 = 40 + 12 \times 2 - (2)^3 = 56m$

105. (a) As the coin falls behind him, force due to air must be backwards. Therefore, the train must be accelerating forward.

106. (a) $\frac{dv}{dt} = -kv^3$ or $\frac{dv}{v^3} = -k\ dt$

Integrating we get, $-\frac{1}{2v^2} = -kt + c$ ...(1)

At $t = 0, v = v_0$ $\therefore -\frac{1}{2v_o^2} = c$

Putting in (1)

$$-\frac{1}{2v^2} = -kt - \frac{1}{2v_0^2} \text{ or } \frac{1}{2v_0^2} - \frac{1}{2v^2} = -kt$$

$$\text{or } \left[\frac{1}{2v_0^2} + kt\right] = \frac{1}{2v^2} \text{ or } \left[1 + 2v_0^2\ kt\right] = \frac{v_0^2}{v^2}$$

$$\text{or } v^2 = \frac{v_0^2}{1 + 2v_0^2\ kt} \quad \text{or} \quad v = \frac{v_0}{\sqrt{1 + 2v_0^2\ kt}}$$

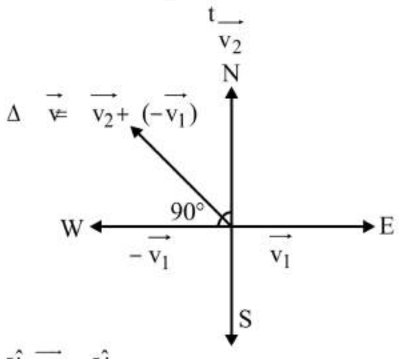
107. (a) $x = \frac{1}{t+5}$ $\therefore v = \frac{dx}{dt} = \frac{-1}{(t+5)^2}$

$\therefore a = \frac{d^2x}{dt^2} = \frac{2}{(t+5)^3} = 2x^3$

Now $\frac{1}{(t+5)} \propto v^{\frac{1}{2}}$ $\therefore$ $\frac{1}{(t+5)^3} \propto v^{\frac{3}{2}} \propto a$

108. (c) Average acceleration $= \frac{\text{change in velocity}}{\text{time interval}}$

$= \frac{\Delta \vec{v}}{t}$



$\vec{v_1} = 5\hat{i}, \vec{v_2} = 5\hat{j}$

$\Delta \vec{v} = (\vec{v}_2 - \vec{v}_1) = \sqrt{v_1^2 + v_2^2 + 2v_1v_2 \cos 90}$

$= \sqrt{5^2 + 5^2 + 0}$ [As $|v_1| = |v_2| = 5$ m/s]

$= 5\sqrt{2}$ m/s

Avg. acc. $= \frac{\Delta \vec{v}}{t} = \frac{5\sqrt{2}}{10} = \frac{1}{\sqrt{2}}$ m/s^2

$\tan \theta = \frac{5}{-5} = -1$

which means θ is in the second quadrant. (towards north-west)

109. (a) Differentiate two times and put $x = 0$.

110. (a) $\frac{dv}{dt} = -2.5\sqrt{v} \Rightarrow \frac{dv}{\sqrt{v}} = -2.5\ dt$

Integrating,

$$\int_{6.25}^{0} v^{-\frac{1}{2}} dv = -2.5 \int_0^t dt$$

$$\Rightarrow \left[\frac{v^{+\frac{1}{2}}}{(\frac{1}{2})}\right]_{6.25}^{0} = -2.5[t]_0^t$$

$$\Rightarrow -2(6.25)^{\frac{1}{2}} = -2.5t \Rightarrow t = 2 \text{ sec}$$

111. (a) $x = x_0 + (ut + \frac{1}{2}at^2)$

At $t = 0, x = -2,$

$\therefore -2 = x_0 + 0$

or $x_0 = -2$

Thus, $0 = -2 + (u \times 1 + \frac{1}{2} \times a \times 1^2)$ ...(i)

and $6 = -2 + (u \times 2 + \frac{1}{2} \times a \times 2^2)$ ...(ii)

After solving equations, we get $u = 0$, $\boldsymbol{a} = 4$ m/s^2.

Now for $t = 3$,

$x = -2 + (u \times 3 + \frac{1}{2} \times 4 \times 3^2)$

$= 16$m.

Clearly it represents motion with constant acceleration.

112. (d) Let the car accelerates for a time t_1 and travels a distance s_1. Suppose the maximum velocity attained by the car be v. Then

$s_1 = \frac{1}{2}\alpha t_1^2$ and $v = \alpha t_1$, $t_1 = v/\alpha$,

$\therefore s_1 = \frac{1}{2} \times \alpha \times (v^2/\alpha^2) = \frac{v^2}{2\alpha}$ ...(1)

Let the car decelerates for a time t_2 and travels a distances s_2. Then

$s_2 = vt_2 - \frac{1}{2}\beta t_2^2$ and $0 = v - \beta t_2$ or $t_2 = \frac{v}{\beta}$

$$\therefore s_2 = v \times \left(\frac{v}{\beta}\right) - \frac{1}{2}\beta\left(\frac{v^2}{\beta^2}\right)$$

$$\text{or } s_2 = \frac{v^2}{\beta} - \frac{v^2}{2\beta} = \frac{v^2}{2\beta} \quad ...(2)$$

As per question,
Let max. velocity is v
then $v = \alpha t_1$ & $v - \beta t_2 = 0$, where $t = t_1 + t_2$

Now $t_1 + t_2 = t$ or $\frac{v}{\alpha} + \frac{v}{\beta} = t$

$\therefore v = \frac{t}{\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)} = \left(\frac{\alpha\beta}{\alpha + \beta}\right)t$ and

$s = s_1 + s_2 = \frac{v^2}{2\alpha} + \frac{v^2}{2\beta} = \frac{v^2}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$

113. (d) Given : $u = 0, t = 5$ sec, $v = 108$ km/hr $= 30$m/s
By eq^n of motion
$v = u + at$

or $a = \frac{v}{t} = \frac{30}{5} = 6\ m/s^2$ $[\because u = 0]$

$S_1 = \frac{1}{2}at^2$

$= \frac{1}{2} \times 6 \times 5^2 = 75$ m

Distance travelled in first 5 sec is 75m.
Distance travelled with uniform speed of 30 m/s is S_2
$395 = S_1 + S_2 + S_3$
$395 = 75 + S_2 + 45$
$\therefore S_2 = 395 - 120 = 275$ m

Time taken to travel 275 m $= \frac{275}{30} = 9.2$ sec

For retarding motion, we have
$0^2 - 30^2 = 2(-a) \times 45$
We get, $a = 10\ m/s^2$

Now by, $S = ut + \frac{1}{2}at^2$

$45 = 30t + \frac{1}{2}(-10)t^2$

$45 = 30t - 5t^2$

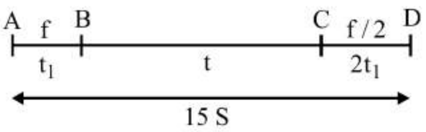
on solving we get,
$t = 3$ sec
Total time taken $= 5 + 9.2 + 3$
$= 17.2$ sec.

114. (d) Distance from A to B $= S = \frac{1}{2}ft_1{}^2$

Distance from B to C $= (ft_1)t$

Distance from C to D $= \frac{u^2}{2a} = \frac{(ft_1)^2}{2(f/2)}$

$= ft_1{}^2 = 2S$



$\Rightarrow S + f t_1 t + 2S = 15S$

$\Rightarrow f t_1 t = 12S$ .... (i)

$\frac{1}{2}f t_1^2 = S$ .... (ii)

Dividing (i) by (ii), we get $t_1 = \frac{t}{6}$

$\Rightarrow S = \frac{1}{2}f\left(\frac{t}{6}\right)^2 = \frac{ft^2}{72}$

115. (a) $h = ut_1 - \frac{1}{2}gt_1^2$

Also $h = ut_2 - \frac{1}{2}gt_2^2$

After simplify above equations, we get

$h = \frac{1}{2}gt_1t_2$.

116. (c) If h is the height of the building, then

$v_A^2 = v^2 + 2gh$

and $v_B^2 = (-v)^2 + 2gh$.

Clearly $v_A = v_B$.

117. (b) Velocity when the engine is switched off

$v = 19.6 \times 5 = 98\ ms^{-1}$

$h_{max} = h_1 + h_2$ where $h_1 = \frac{1}{2}at^2$ & $h_2 = \frac{v^2}{2a}$

$h_{max} = \frac{1}{2} \times 19.6 \times 5 \times 5 + \frac{98 \times 98}{2 \times 9.8}$

$= 245 + 490 = 735$ m

118. (b) Height attained by balls in 2 sec is

$= \frac{1}{2} \times 9.8 \times 4 = 19.6$m

the same distance will be covered in 2 second (for descent)
Time interval of throwing balls, remaining same. So, for two balls remaining in air, the time of ascent or descent must be greater than 2 seconds. Hence speed of balls must be greater than 19.6 m/sec.

119. (a) Clearly distance moved by 1st ball in 18s = distance moved by 2nd ball in 12s.
Now, distance moved in 18 s by 1st ball

$= \frac{1}{2} \times 10 \times 18^2 = 90 \times 18 = 1620$ m

Distance moved in 12 s by 2nd ball

$= ut + \frac{1}{2}gt^2$ $\therefore 1620 = 12v + 5 \times 144$

$\Rightarrow v = 135 - 60 = 75\ ms^{-1}$

120. (a) $\because h = \frac{1}{2}gt^2$

$\therefore h_1 = \frac{1}{2}g(5)^2 = 125$

$$h_1 + h_2 = \frac{1}{2} g(10)^2 = 500$$

$$\Rightarrow h_2 = 375$$

$$h_1 + h_2 + h_3 = \frac{1}{2} g(15)^2 = 1125$$

$$\Rightarrow h_3 = 625$$

$$h_2 = 3h_1, h_3 = 5h_1$$

or $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

121. (b) As the ball moves down from height 'h' to ground the P.E. at height 'h' is converted to K.E. at the ground (Applying Law of conservation of Energy).

Hence, $\frac{1}{2} m_A v_A^2 = m_A g h_A$ or $v_A = \sqrt{2gh}$;

Similarly, $v_B = \sqrt{2gh}$ or $v_A = v_B$

122. (c) $h = \frac{1}{2} g T^2$

In $\frac{T}{3}$ sec, the distance travelled $= \frac{1}{2} g \left(\frac{T}{3}\right)^2 = \frac{h}{9}$

$\therefore$ Position of the ball from the ground

$$= h - \frac{h}{9} = \frac{8h}{9} m$$

123. (a) Before hitting the ground, the velocity v is given by

$$v^2 = 2gd$$

Further, $v'^2 = 2g \times \left(\frac{d}{2}\right) = gd$;

$$\therefore \left(\frac{v}{v'}\right) = \sqrt{2} \quad \text{or} \quad v = v'\sqrt{2}$$

As the direction is reversed and speed is decreased and hence graph (a) represents these conditions correctly.

124. (b) Time taken by the stone to reach the water level

$$t_1 = \sqrt{\frac{2h}{g}}$$

Time taken by sound to come to the mouth of the well,

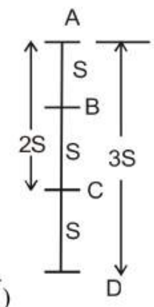
$$t_2 = \frac{h}{v}$$

$\therefore$ Total time $t_1 + t_2 = \sqrt{\frac{2h}{g}} + \frac{h}{v}$

125. (b) $S = AB = \frac{1}{2} g t_1^2 \Rightarrow 2S = AC = \frac{1}{2} g (t_1 + t_2)^2$

and $3S = AD = \frac{1}{2} g (t_1 + t_2 + t_3)^2$

$$t_1 = \sqrt{\frac{2S}{g}}$$



$$t_1 + t_2 = \sqrt{\frac{4S}{g}}, \; t_2 = \sqrt{\frac{4S}{g}} - \sqrt{\frac{2S}{g}}$$

$$t_1 + t_2 + t_3 = \sqrt{\frac{6S}{g}}$$

$$t_3 = \sqrt{\frac{6S}{g}} - \sqrt{\frac{4S}{g}}$$

$$t_1 : t_2 : t_3 :: 1 : (\sqrt{2} - \sqrt{1}) : (\sqrt{3} - \sqrt{2})$$

126. (a) $h = ut + \frac{1}{2} g t^2$

$$h = \frac{1}{2} g t^2 \; [\because u = 0]$$

$$\therefore t = \sqrt{2h/g}$$

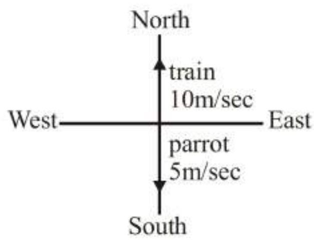
127. (c)

128. (c) Velocity of A is same as that of B in magnitude but opposite in direction.

129. (d) So by figure the velocity of parrot w.r.t. train is $= 5 - (-10) = 15$ m/sec

so time taken to cross the train is

$$= \frac{\text{length of train}}{\text{relative velocity}} = \frac{150}{15} = 10 \text{ sec}$$



130. (b) Relative speed of each train with respect to each other be, $v = 10 + 15 = 25$ m/s

Here distance covered by each train = sum of their lengths $= 50 + 50 = 100$ m

$\therefore$ Required time $= \frac{100}{25} = 4$ sec.

131. (a) According to question,

$V(x) = bx^{-2n}$

So, $\frac{dv}{dx} = -2\,nb\,x^{-2n-1}$

Acceleration of the particle as function of x,

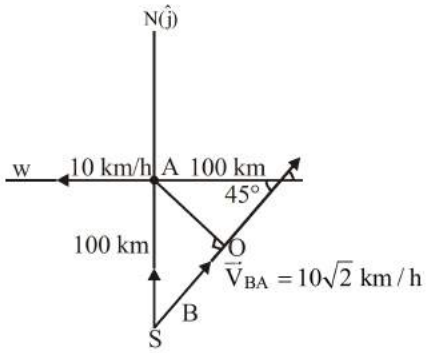
$$a = v\frac{dv}{dx} = bx^{-2n}\left\{b(-2n)x^{-2n-1}\right\}$$

$$= -2nb^2x^{-4n-1}$$

132. (a) $\vec{V}_A = 10(-\hat{i})$

$$\vec{V}_B = 10(\hat{j})$$

$$\vec{V}_{BA} = 10\hat{j} + 10\hat{i} = 10\sqrt{2} \text{ km/h}$$



Distance OB = 100 cos 45° = $50\sqrt{2}$ km

Time taken to each the shortest distance between

A and B = $\frac{OB}{V_{BA}} = \frac{50\sqrt{2}}{10\sqrt{2}} = 5h$

133. (a) $s = ut + \frac{1}{2}at^2$

$-65 = 12t - 5t^2$ on solving we get, $t = 5s$

134. (d) Speed to cover 1200 m by scootarist

$v_r \times 60 = 1200 \Rightarrow v_r = 20$

speed to overtake bus

$v = v_r + 10 = 30$ m/s

135. (d) For A to B

$S = \frac{1}{2}gt^2$ ...(*i*)

For A to C

$2S = \frac{1}{2}gt'^2$ ...(*ii*)

Dividing (i) by (ii) we get

$\frac{t}{t'} = \frac{1}{\sqrt{2}}$

136. (b) $y_1 = 10t - 5t^2$; $y_2 = 40t - 5t^2$

for $y_1 = -240$m, t = 8s

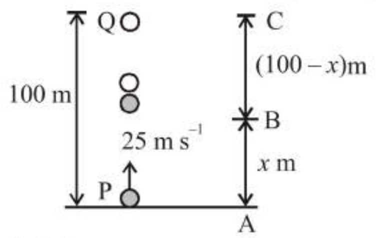
$\therefore$ $y_2 - y_1 = 30t$ for $t \leq 8s$.

for $t > 8s$,

$y_2 - y_1 = 240 - 40t - \frac{1}{2}gt^2$

137. (d) Let the two balls Pand Q meet at height x m from the ground after time t s from the start.

We have to find distance, $BC = (100 - x)$



For ball P

$S = x$ m, $u = 25$ m s^{-1}, $a = -g$

From $S = ut + \frac{1}{2}at^2$

$x = 25t - \frac{1}{2}gt^2$ .... (i)

For ball Q

$S = (100 - x)$ m, $u = 0$, $a = g$

$\therefore$ $100 - x = 0 + \frac{1}{2}gt^2$ .... (ii)

Adding eqns. (i) and (ii), we get

$100 = 25t$ or $t = 4$ s

From eqn. (i),

$x = 25 \times 4 - \frac{1}{2} \times 9.8 \times (4)^2 = 21.6$ m

Hence distance from the top of the tower

$= (100 - x)$ m $= (100 - 21.6$ m$) = 78.4$ m

138. (c) As we know, distance traversed in n^{th} second

$S_n = u + \frac{1}{2}a(2n - 1)$

Here, $u = 0$, $a = g$

$\therefore$ $S_n = \frac{1}{2}g(2n - 1)$

Distance traversed in 1st second i.e., $n = 1$

$S_1 = \frac{1}{2}g(2 \times 1 - 1) = \frac{1}{2}g$

Distance traversed in 2nd second i.e., $n = 2$

$S_2 = \frac{1}{2}g(2 \times 2 - 1) = \frac{3}{2}g$

Distance traversed in 3rd second i.e., $n = 3$

$S_3 = \frac{1}{2}g(2 \times 3 - 1) = \frac{5}{2}g$

$\therefore$ $S_1 : S_2 : S_3 = \frac{1}{2}g : \frac{3}{2}g : \frac{5}{2}g = 1:3:5$

139. (d) Let u be the initial velocity that have to find and a be the uniform acceleration of the particle.

For $t = 3$s, distance travelled $S = 12$ m and

for $t = 3 + 3 = 6$ s distance travelled $S' = 12 + 30 = 42$ m

From, $S = ut + 1/2\,at^2$

$12 = u \times 3 + \frac{1}{2} \times a \times 3^2$

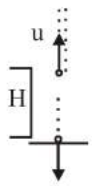
or $24 = 6u + 9a$ ...(i)

Similarly, $42 = u \times 6 + \frac{1}{2} \times a \times 6^2$

or $42 = 6u + 18a$ ...(ii)

On solving, we get $u = 1$ m s^{-1}

140. (c) Speed on reaching ground $v = \sqrt{u^2 + 2gh}$



Now, $v = u + at$

$\Rightarrow$ $\sqrt{u^2 + 2gh} = -u + gt$

Time taken to reach highest point is $t = \frac{u}{g}$,

$\Rightarrow$ $t = \frac{u + \sqrt{u^2 + 2gH}}{g} = \frac{nu}{g}$ (from question)

$\Rightarrow$ $2gH = n(n - 2)u^2$