विध्न विचारत भीरु जन, नहीं आरम्भे काम,
विपति देख छोड़े तुरंत मध्यम मन कर श्याम।
पुरुष सिंह संकल्प कर, सहते विपति अनेक,
'बना' न छोड़े ध्येय को, रघुबर राखे टेक।।

रचितः मानव धर्म प्रणेता
सद्गुरु श्री रणछोड़दासजी महाराज

KINEMATICS

Some questions (Assertion–Reason type) are given below. Each question contains STATEMENT – 1 (Assertion) and STATEMENT – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. So select the correct choice :

Choices are :

(A) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is** a correct explanation for Statement – 1.
(B) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is NOT** a correct explanation for Statement – 1.
(C) Statement – 1 is True, Statement – 2 is False.
(D) Statement – 1 is False, Statement – 2 is True.

9. **STATEMENT – 1**
The instantaneous velocity does not depend on instantaneous position vector.

STATEMENT – 2
The instantaneous velocity and average velocity of a particle are always same.

10. **STATEMENT – 1**
A man who can swim at a speed v relative to water wants to cross the river of width d, flowing with speed u. He cannot reach a point P opposite him across the river if u > v.

STATEMENT – 2
The time to reach the opposite point P across the river is $\frac{d}{\sqrt{v^2 - u^2}}$ and if u > v time will come out to be imaginary.

11. **STATEMENT – 1**
A balloon ascends from the surface of earth with constant speed. When it was at a height 50 m above the ground, a packet is dropped from it. To an observer on the balloon, the displacement of the packet, from the moment it is dropped to the moment it reaches the surface of earth, is 50 m.

STATEMENT – 2
Displacement (vector) depends upon the reference frame used to measure it.

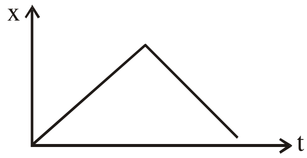
12. **STATEMENT – 1**
If two particles, moving with constant velocities are to meet, the relative velocity must be along the line joining the two particles.

STATEMENT – 2
Relative velocity means motion of one particle as viewed from the other.

13. **STATEMENT – 1**
Two balls are dropped one after the other from a tall tower. The distance between them increases linearly with time (elapsed after the second ball is dropped and before the first hits ground).

STATEMENT – 2
Relative acceleration is zero, whereas relative velocity non–zero in the above situation.

14. **STATEMENT – 1**
x–t graph, for a particle undergoing rectilinear motion, can be as shown in the figure.



STATEMENT – 2
Infinitesimal changes in velocity are physically possible only in infinitesimal time.

15. **STATEMENT – 1**
When a particle moves along a straight line magnitude of its average velocity is equal to its average speed over any time interval.

STATEMENT – 2
For one dimensional motion displacement and distance both are same.

16. **STATEMENT – 1**
$\left|\frac{d\vec{v}}{dt}\right|$ is equal to $\frac{d}{dt}|\vec{v}|$. Here $\vec{v}$ has its usual meaning.

STATEMENT – 2
If a particle is acted upon by a external force its momentum must change.

17. **STATEMENT – 1**
Area under velocity–time graph gives displacement.

STATEMENT – 2
Area under acceleration–time graph gives velocity.

18. **STATEMENT – 1**
When a particle is thrown obliquely from the surface of the Earth, it always moves in a parabolic path, provided the air resistance is negligible.

STATEMENT – 2
A projectile motion is a two dimensional motion.

19. **STATEMENT – 1**
The average speed and average velocity of the particle are different physical quantities.

STATEMENT – 2
The average speed and average velocity have same dimensions.

20. **STATEMENT – 1**
Two different particles are projected horizontally with different speeds, they reach the ground simultaneously. (Assuming g is constant)

STATEMENT – 2
The vertical component of the initial velocity is zero.

21. **STATEMENT – 1**
Two particles starts moving with velocities $\vec{V}_1$ & $\vec{V}_2$ respectively in xy–plane. They can meet only if component of their velocity perpendicular to line joining them are equal.

STATEMENT – 2
Relative velocity of a body w.r.t. other body is calculated along line joining two bodies.

22. **STATEMENT – 1**
A man can cross river of width d in minimum time t. On increasing river velocity, minimum time to cross the river by man will remain unchanged.

STATEMENT – 2

Velocity of river is perpendicular to width of river. So time to cross the river is independent of velocity of river.

23. **STATEMENT – 1**
When a body is dropped or thrown horizontally from the same height, it reaches the ground at the same time.

STATEMENT – 2
They have same acceleration and same initial speed in vertical direction.

24. **STATEMENT – 1 :** The maximum range along the inclined plane, when thrown downward is greater than that when thrown upward along the same inclined plane with constant velocity.

STATEMENT – 2 : The maximum range along inclined plane is independent of angle of inclination.

25. **STATEMENT – 1 :** If particle is moving in straight line with constant acceleration or retardation its velocity may be zero at particular instant.

STATEMENT – 2 : If particle moves along a straight line it may be accelerated, decelerated or can move with a constant velocity.

26. **STATEMENT – 1 :** In uniform circular motion acceleration is constant.

STATEMENT – 2 : In uniform circular motion magnitude of acceleration is $\frac{V^2}{r}$ and direction is always towards the centre.

27. **STATEMENT – 1 :** A particle is projected at an angle θ (< 90) to horizontal, with a velocity u. When particle strikes the ground its speed is again u.

STATEMENT – 2 : Velocity along horizontal direction remains same but velocity along vertical direction is changed. When particle strikes the ground, magnitude of final vertical velocity is equal to magnitude of initial vertical velocity.

28. **STATEMENT – 1 :** Two particles of different mass, projected with same velocity at same angles. The maximum height attained by both the particles will be same.

STATEMENT – 2 : The maximum height of projectile is independent of particle mass

29. **STATEMENT – 1 :** When a particle moves in a circle with a uniform speed, its velocity and acceleration both changes.

STATEMENT – 2 : The centripetal acceleration in circular motion is dependent on angular velocity of the body.

30. **STATEMENT – 1 :** The net acceleration of a particle in circular motion is always directed radially inward.

STATEMENT – 2 : Whenever a particle moves in a circular path an acceleration exists which is directed towards the centre.

31 **STATEMENT – 1 :** A coin is allowed to fall in a train moving with constant velocity. Its trajectory is parabola as seen by observer attached to the train.

STATEMENT – 2 : An observer on ground will see the path of coin as a parabola.

32. **STATEMENT – 1 :** In a projectile motion from ground R=H at $\theta = \tan^{-1}(4)$.

STATEMENT – 2 : Max range of projectile is proportional to (velocity)^2 and $\left(\frac{1}{g}\right)$.

33. **STATEMENT – 1 :** When speed of projection of a body is made n-times, its time of flight becomes n times.

STATEMENT – 2 : This is because range of projectile become n times.

34. **STATEMENT – 1 :** In a uniformly accelerated motion, acceleration time graph is straight line with positive slope.

STATEMENT – 2 : Acceleration is rate of change of velocity.

35. **STATEMENT – 1 :** Horizontal velocity in projectile motion remains constant.

STATEMENT – 2 : Acceleration due to gravity is vertical.

36. **STATEMENT – 1 :** In uniform circular motion acceleration is constant.

STATEMENT – 2 : In uniform circular motion speed is constant.

37. **STATEMENT – 1 :** A particle is moving on a horizontal surface. Its path will be straight line if initial velocity and acceleration are along same horizontal surface.

STATEMENT – 2 : Angle between $\vec{u}$ and $\vec{a}$ determine path therefore, it may be accelerated or retarded curvilinear.

38. **STATEMENT – 1 :** If air resistance is considered then time of ascent and time of descent will be different.

STATEMENT – 2 : Magnitudes of acceleration will be different in upwards and downward motion.

39. **STATEMENT – 1 :** For maximum height H of a projectile when the maximum range is R the only valid relation is that H is 50% of R.

STATEMENT – 2 : $R = \frac{u^2 \sin 2\theta}{g}$ and $H = \frac{u^2 \sin^2 \theta}{2g}$.

40. **STATEMENT – 1 :**A particle in motion may not have variable speed but constant velocity.

STATEMENT – 2 : A particle having non–zero acceleration may move with constant speed.

41. **STATEMENT – 1 :** A body, whatever its motion, is always at rest in a frame of reference which is fixed to the body itself.

STATEMENT – 2 : The relative velocity of a body with respect to itself is zero.

42. **STATEMENT – 1 :** A body having non zero acceleration can have a constant velocity.

STATEMENT – 2 : Acceleration is the rate of change of velocity.

43. **STATEMENT – 1 :** During a turn, the value of centripetal force should be less than the limiting frictional force.

STATEMENT – 2 : The centripetal force is provided by the frictional force between the tyre and the road.

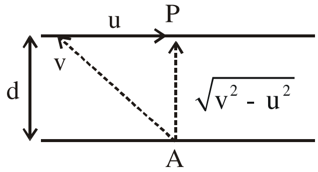
Hint & Solution

9.	(C)	10.	(A)	11.	(D)	12.	(A)
13.	(A)	14.	(D)				
15.	Both statements are false.	16.	(D)	17.	(C)		
18.	(D)	19.	(B)	20.	(A)	21.	(C)
22.	(A)	23.	(A)	24.	(C)	25.	(B)
26.	(D)	27.	(A)	28.	(A)	29.	(B)
30.	(D)	31.	(D)	32.	(B)	33.	(C)
34.	(D)	35.	(A)	36.	(D)	37.	(D)
38.	(A)	39.	(A)	40.	(B)	41.	(A)
42.	**(D)**	**43.**	**(A)**				

9. As $\vec{v} = \frac{d\vec{s}}{dt}$, hence statement 1 is correct.

Instantaneous velocity is same always to average velocity if the particle is moving with constant velocity.

10. Time to cross the river $t = \frac{d}{\sqrt{v^2 - u^2}}$.



11. To an observer on the balloon, the ground is moving.

12. Suppose motion of 1 is viewed from 2 then as 2 is stationary. If 1 is to meet it, it 1 must come straight towards 2 i.e., the relative velocity must be along 1 – 2.

14. At the high point of the graph velocity (slope of x–t curve) charges suddenly from a positive to a negative value. This is physically impossible.

17. Area under acceleration–time graph gives change in velocity and not velocity.

18. The particle will move in a parabolic path till acceleration (due to gravity) is constant. For this the particle should be near the surface of the Earth and air resistance should be negligible.

26. In uniform circular motion direction of acceleration is always along the radial direction. As particle is rotating so radial vector keeps on changing.

27. $U_x = 0, \quad a_x = 0$

$\Rightarrow$ $V_x = U_x + a_x T = U_x$

$U_y = u \sin\theta$; $a_y = -g$

$\therefore$ $V_y = u\sin\theta - gt$

$$= u\sin\theta - g.\frac{2u\sin\theta}{g}\ ; V_y = -u\sin\theta.$$

28. $H = \dfrac{u^2\sin^2\theta}{2g}$ i.e., it is independent of mass of projectile.

29. In uniform circular motion, the magnitude of velocity and acceleration remains same, but due to change in direction of motion, the direction of velocity and acceleration changes. Also the centripetal acceleration is given by $a = \omega^2 r$.

30. In case of non–uniform circular motion, net acceleration will not be directed towards centre.

31. For the observer attached with train, the initial horizontal velocity of coin and train are same, thus observer will find its path as a straight line.

32. Use $R = \dfrac{u^2\sin^2\theta}{g}$

Range in a function of θ also.

33. As $T = \dfrac{2u\sin\theta}{g} \therefore T' = \dfrac{2nu\sin\theta}{g}$

$T' = nT$

$R = u\cos\theta T \therefore R' = nu\cos\theta.nT$

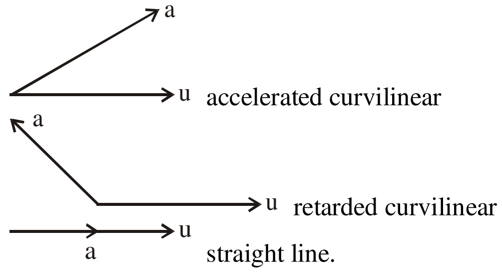
$R' = n^2R$

34. Positive slope indicates that acceleration increases uniformly with time. It is not uniform.

35. Since no force is present as horizontal direction velocity of constant.

36. Direction of acceleration changes.

37.



38.

39. Because $R_{max} = \dfrac{u^2}{g}$ [for $\theta = 45^\circ$]

and $H_{max} = \dfrac{u^2}{2g}$ $\therefore$ H_{max} can be 50% of range.

41. A body has no relative motion with respect to itself. Hence if a frame of reference of the body is fixed, then the bodies will be always at relatively rest in this frame of reference. So 'a' is correct.

42. Acceleration is the rate of change of velocity i.e., $a = \dfrac{d\nu}{dt}$

43. If the value of frictional force μmg is less than centripetal force, then it is not possible for a vehicle to take twin and the bicycle would take a over turn. Thus condition for no over turning is

$$\mu mg \geq \frac{m\nu^2}{r}$$

So statement – I and statement – II are correct and statement – II is the correct explanation of statement – I. Hence (a) is correct.