DDS ACADEMY

KINEMATICS **DPP-1 JEE**

ADVANCE LEVEL – I

1. A car moving on a straight road with a speed 20m/s. At t = 0, the driver of the car applies the brakes after watching an obstacle 150m ahead. After application of brakes the car retards with2m/s^2. Find the position of the car from the obstacle at t = 15s.

2. A balloon is ascending vertically with an acceleration of 1 m/s^2. Two stones are dropped from it at an interval of 2 s. Find the distance between them 1.5 sec after the second stone is released.

3. A particle moves in x-y plane with constant acceleration a directed along the negative y-axis. The equation of motion of the particle has the form $y = px - qx^2$ where p and q are positive constants. Find the velocity of the particle at the origin of co-ordinate.

4. A boy standing on a long railroad car throws a ball straight upwards. The car is moving on the horizontal road with an acceleration of 1 m/s^2 and the projection velocity in the vertical direction is 9.8 m/s. How far behind the boy will the ball fall on the car?

5. A man on the road is just 9 m behind the entrance door of a train when the train begins to take motion from rest with a uniform acceleration of 2 m/s^2. The man immediately starts and runs with a uniform speed to get into the train. He is just able to get in. Find the speed of his running.

6. To a man walking at 7 km/hr due west the wind appears to blow from the North West, but when he walks at 3 km/hr due west the wind appears to blow from the north. What is the actual direction of the wind & what is its velocity.

7. The reaction time (Time lag between observing and reacting to the stimuli) for an automobile driver is 0.7 sec. If the automobile can be decelerated at 5 m/s^2, find the total distance covered in coming to a stop from an initial velocity of 72 km/hr after the signal is observed.

8. A particle is projected vertically upwards and at the same time another particle is let fall to meet it. If the particles have equal speeds when they meet, show that one of them has travelled a distance equal to three times to that travelled by the other.

9. A balloon is rising up with a velocity of 10 ms^{-1} and a bag is dropped from it when its height from the ground is 40 m. calculate the time taken by the bag to reach the ground.

10. A point traversed half the distance with a velocity v_0. The remaining part of the distance was covered with velocity v_1 for half the time, and with velocity v_2 for the other half of the time. Find the mean velocity of the point averaged over the whole time of motion.

11. A man is walking on a horizontal road at 3 km/hr. The rain appears to him to come down vertically at the rate of 3 km/hr. Calculate the actual velocity and the direction of the rain fall.

12. A particle A is moving along a straight line with velocity 3 m/s and another particle B has a velocity 5 m/s at an angle 30^o to the path of A. Find the velocity of B relative to A.

13. A river 400 m wide is flowing at a rate of 2.0 m/s. A boat is sailing at a velocity of 10 m/s with respect to the water, in a direction perpendicular to the river.
    (a) Find the time taken by the boat to reach the opposite bank.
    (b) How far from the point directly opposite to the starting point does the boat reach the opposite bank?

14. An aero plane is flying in a horizontal direction with a velocity 600 km/hr and at a height of 1960 m. When it is vertically below the point A, on the ground, a body is dropped from it. The body strikes the ground at point B. Calculate the distance AB.

15. A particle is projected from a point A with a velocity u at an angle θ (upward) to the horizontal. At a certain point B, it moves at right angle to its initial direction. Find the time upto that instant.

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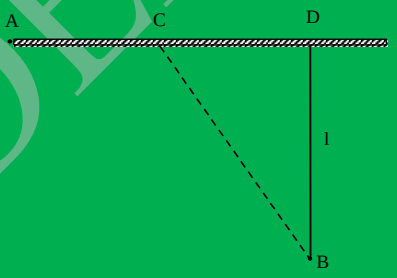
ADVANCE LEVEL – II

1. Three particles A, B and C are situated at the vertices of an equilateral triangle ABC of side d at t = 0. Each of the particles moves with constant speed v. A always has its velocity along AB, B along BC and C along CA. At what time will the particle meet each other?

2. At the instant the traffic light turns green, an automobile starts with a constant acceleration of 2.2 m/s^2. At the same instant a truck, travelling with a constant speed of 9.5 m/s, overtakes and passes the automobile.
   (a) How far beyond the starting point will the automobile overtake the truck?
   (b) How fast will the car be traveling at the instant?
   (It is instructive to plot a qualitative graph of 'x' versus t for each vehicle.)

3. The points A, B and C lie on the same straight line, the distance AB being 60 m. a particle crosses the point A with a velocity 2 m/s and moves with uniform acceleration along the straight line. After crossing the point B, it takes 10 s to reach C with velocity 5 m/s. Find the acceleration of the particle.

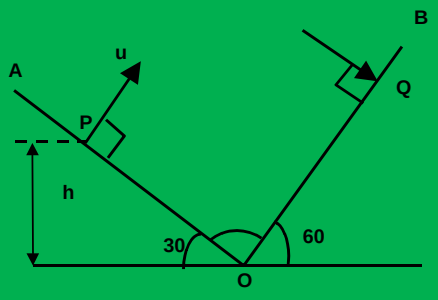
4. From point A located on a highway (Fig.) one has to get by car as soon as possible to point B located in the field at a distance ℓ from the highway. It is known that the car moves in the field n times slower than the highway. At what distance from point D one must turn off the highway?



5. A man wishes to cross a river of width 120 m by a motor boat. His rowing speed in still water is 3m/s, and his maximum walking speed is 1m/s. The river flow velocity is 4 m/s.
   (a) Obtain the path which he should take to get to the point directly opposite to this starting point in the shortest time.
   (b) Also, find the time which he takes to reach his destination

6. Two particles move in a uniform gravitational field with an acceleration g. At the initial moment the particles were located at one point in space and moved with velocities v_1 = 3.0 m/s and v_2 = 4.0 m/s horizontally in opposite directions. Find the distance between the particles at the moment when their velocity vectors become mutually perpendicular.

7. Two inclined planes OA and OB having inclination with horizontal) 30^0 and 60^0 respectively, intersect each other at O as shown in figure. A particle is projected from point P with velocity u $=10\sqrt{3}$ m/s. Along a direction perpendicular to plane OA. If the particle strikes plane OB perpendicularly at Q, calculate



   (a) Velocity with which particle strikes the plane OB,
   (b) Time of flight,
   (c) Vertical height h of P from O,
   (d) Maximum height from O, attained by the particle and

(e) Distance PQ. ($g = 10\ m/s^2$)

8. An aero plane has to go from a point A to another point B, 500 km away due 30^0 east of north. A wind is blowing due north at a speed of 20 m/s. the air-speed of the plane is 150 m/s.
(a) Find the direction in which the pilot should head the plane to reach the point B.
(b) Find the time taken by the plane to go from A to B.

9. Point A moves uniformly with velocity v so that the vector $\bar{v}$ continually "aimed" at point B which in its turn moves rectilinearly and uniformly with velocity u < v. At the initial moment of time $v \perp u$ and the points are separated by a distance ℓ. Find the time when point A catches point B.

10. A ship A streams due north at 16 km/hr and a ship B due west at 12 km/hr. At a certain instant B is 10 km north-east of A. Find the velocity of A relative to B. Find also the nearest distance of approach of ships.

11. A particle is projected up an inclined plane of inclination β at an elevation α to the horizon. Show that -
(a) $\tan\alpha = \cot\beta + 2\tan\beta$, if the particle strikes the plane at right angles.
(b) $\tan\alpha = 2\tan\beta$, if the particle strikes the plane horizontally.

12. The velocity of a particle moving in the positive direction of x-axis varies as $v = \alpha\sqrt{x}$ where α is a positive constant. Assuming that at the moment t = 0, the particle was located at x = 0. Find -
(a) The time dependence of the velocity and the acceleration of the particle
(b) The mean velocity of the particle averaged over the time that the particle takes to cover first S meters of the path.

13. A perfectly elastic ball is thrown from the foot of a plane whose inclination to horizon is β. If after striking the plane at a distance R from the point of projection it rebounds and retraces its former path. Find the velocity of projection.

14. A motor boat with its engine on running river & blown over by a horizontal wind is observed to travel at 20 km/hr in a direction 53^o east of north. The velocity of the boat with its engine on, in still water blown over by the horizontal wind is 4 km/hr eastward & the velocity of the boat with its engine on, over the running river in the absence of wind is 8 km/hr due south. Calculate:-
(a) The velocity of the boat in magnitude & direction over still water in the absence of wind.
(b) The velocity of the wind in magnitude & direction.

15. A particle is projected with a velocity u at an angle θ with the horizontal. Find the radius of the curvature of the parabola traced out by the particle at the point where velocity makes an angle $\frac{\theta}{2}$ with the horizontal.

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MAINS LEVEL – I

1. If angle (θ) between velocity vector and acceleration vector is $90 < \theta < 180$. The body is moving on:
   (A) Straight line path with retardation
   (B) Straight line with acceleration
   (C) Curvilinear path with acceleration
   (D) Circular path with retardation

2. A ball is projected from ground with a speed of 20 m/s at an angle of 45° with horizontal. There is a wall of 25 m height at a distance of 10 m from the projection point. The ball will hit the wall at a height of
   (A) 5 m
   (B) 7.5 m
   (C) 10 m
   (D) 12.5 m

3. A body is thrown horizontally from a tower, 100 m high with a velocity 10 ms^{-1}. It is moving at an angle 45^0 with horizontal after:
   (A) 2 sec
   (B) 4 sec
   (C) 1 sec
   (D) 3 sec

4. A motor boat is to reach at a point 30^0 upstream on other side of a river flowing with velocity 5 m/s. Velocity of motor boat with respect to water is $5\sqrt{3}$ m/sec. The driver should steer the boat an angle:
   (A) 30^0 w.r.t. the line of destination from starting point
   (B) 60^0 w.r.t. normal to the bank
   (C) 120^0 w.r.t. stream direction
   (D) None of these

5. The greatest height to which a man can throw a stone is h. The greatest distance to which he can throw will be:
   (A) h/2
   (B) h
   (C) 2 h
   (D) 4 h

6. Pick up the correct statements:
   (A) Area under acceleration - time graph gives velocity
   (B) Area under acceleration – time graph gives change in velocity
   (C) Path of projectile as seen by another projectile is parabola.
   (D) A body, whatever its motion is, always at rest in a frame of reference fixed to body itself

7. A car is moving eastwards with velocity 10 m/s. In 20 sec, the velocity changes to 10 m/s northwards. The average acceleration in this time:
   (A) $1/\sqrt{2}$ m s^{-2} towards North-West
   (B) $1/\sqrt{2}$ ms^{-2} towards North--East
   (C) 1/2 m s^{-2} towards North-West
   (D) 1/2 ms^{-2} towards North

8. A body moving with a uniform acceleration has velocities of u and v when passing through points A and B in its path. The velocity of the body midway between A and B is
   (A) $\frac{u+v}{2}$
   (B) $\sqrt{\frac{u^2+v^2}{2}}$
   (C) $\sqrt{uv}$
   (D) None of these

9. A particle is projected from a horizontal plane with $8\sqrt{2}$ m/s at an acute angle. At highest point its velocity is found to be 8 m/s. It range will be:

(A) 12.8 m (B) 3.2 m
(C) 5 m (D) 4.6 m

10. A projectile is projected at an angle $\alpha(>45°)$ with an initial velocity u. The time t, at which its horizontal velocity will equal the vertical velocity.

(A) $t = \frac{u}{g}(\cos\alpha - \sin\alpha)$ (B) $t = \frac{u}{g}(\cos\alpha + \sin\alpha)$

(C) $t = \frac{u}{g}(\sin\alpha - \cos\alpha)$ (D) $t = \frac{u}{g}(\sin^2\alpha - \cos^2\alpha)$

11. The position vector of a particle in a circular motion about the origin sweeps out equal area in equal time, its:

(A) Velocity remains constant (B) speed remains constant
(C) Acceleration remains constant (D) tangential acceleration remain constant

12. Two particles start moving along the same straight line starting at the same moment from the same point. The first moves with constant velocity u and the second with constant acceleration f. During the time that elapses before second catches the first, the greatest distance between the particles is

(A) $\frac{u}{f}$ (B) $\frac{u^2}{2f}$

(C) $\frac{f}{2u^2}$ (D) $\frac{u^2}{f}$

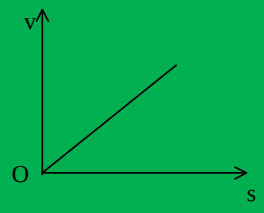
13. For a particle moving along a curved path, velocity is directed

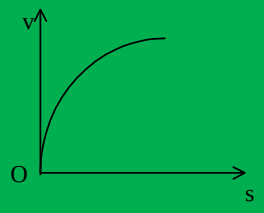
(A) along tangent (B) along normal to the tangent outward
(C) along normal to the tangent inward (D) None of these

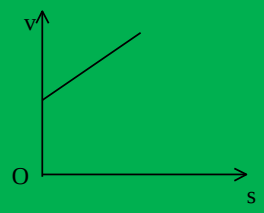
14. Choose the wrong statement

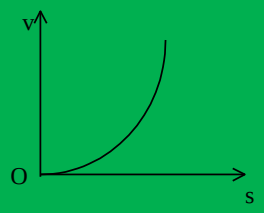
(A) Zero velocity of a particle does not necessarily mean that its acceleration is zero.
(B) Zero acceleration of a particle does not necessarily mean that its velocity is zero.
(C) If speed of a particle is constant, its acceleration must be zero.
(D) none of these

15. A body starts from rest moves along a straight line with constant acceleration. The variation of speed v with distance s is given by graph

(A) 

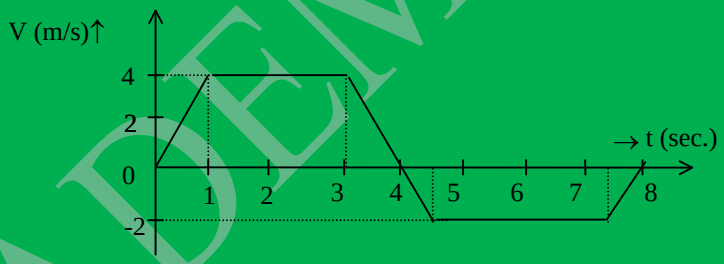
(B) 

(C) 

(D) 

MAINS LEVEL - II

1. The velocity-time graph of a linear motion is shown in figure. The displacement from the origin after 8 sec. is



(A) 5 m
(B) 16 m
(C) 8 m
(D) 6 m

2. A disc of radius R is rotating inside a room, A boy standing at the rim of the disc, finds the water droplets falling from the ceiling is always hitting on his head. As one drop hits his head the next one starts from the ceiling. If height of the roof above his head is H. Angular velocity of disc is:

(A) $\pi\sqrt{\frac{2gR}{H^2}}$
(B) $\pi\sqrt{\frac{2gH}{R^2}}$
(C) $\pi\sqrt{\frac{2g}{H}}$
(D) $2\pi\sqrt{\frac{2g}{H}}$

3. A particle is detached from the rim of a rotating disc of radius 70 cm and angular frequency 30 rpm. The plane of the disc is situated 2.5 m above the horizontal floor. The horizontal distance covered by particle before hitting the floor:
(A) 6.28 m
(B) 3.14 m
(C) 1.57 m
(D) 15.7 m

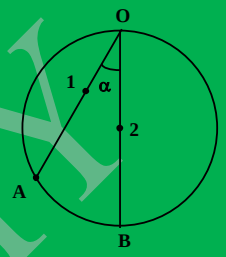
4. A swimmer wishes to reach directly opposite bank of a river, flowing with velocity 8 m/s. The swimmer can swim 10 m/s in still water. The width of the river is 480 m. Time taken by him to do so:
(A) 60 sec
(B) 48 sec
(C) 80 sec
(D) None of these

5. The relation between time t and distance x is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is: (if v is velocity of the particle)
(A) $2\alpha v^3$
(B) $2\beta v^2$

(C) $2\alpha\beta v^2$ (D) $2\beta^2 v^3$

6. A projectile of mass m is fired with velocity v at 45^0 to horizontal from a point P. Neglecting air resistance, the magnitude of change of momentum between the leaving point P and the arriving point Q (at the same level) is:
(A) $mv/\sqrt{2}$ (B) 2 mv
(C) 1/2 mv (D) $\sqrt{2}$ mv

7. Two particles 1 and 2 are allowed to descend on the two frictionless chords OA and OB of a circle, at the same instant from O . The ratio of the velocities of the particles 1 and 2 respectively, when they reach on the circumference will be
(A) sin α (B) tan α
(C) cos α (D) none of these



8. A man is firing a gun putting it over his shoulders. To attain maximum range on the ground, the angle of projection will be
(A) 45^0 (B) more than 45^0
(C) less than 45^0 (D) 0^0

9. A ball rolls off the top of a stair way with a horizontal velocity u m/s. If the steps are h meter high and b meters wide, the ball will hit the edge of the nth step, if:
(A) $n = 2h\ u/g\ b^2$ (B) $n = 2h\ u^2/g\ b^2$
(C) $n = 2h\ u^2/g\ b$ (D) $n = h\ u^2/g\ b^2$

10. A man can swim at a speed of 5 km/h w.r.t. water. He wants to cross a 1.5 km wide river flowing at 3 km/h. He keeps himself always at an angle of 60^o with the flow direction while swimming. The time taken by him to cross the river will be
(A) 0.25 hr. (B) 0.35 hr.
(C) 0.45 hr. (D) 0.55 hr.

11. In the above question if the man reaches the opposite bank of the river at a distance of x from the directly opposite point on the river then, x will be equal to
(A) 1.6 km (B) 1.75 km
(C) 1.9 km (D) 2.1 km

12. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/sec. A plumb bob is suspended from the roof of the car by a light rigid rod of length 1.00 m. The angle made by the rod with the track is:
(A) zero (B) 30°
(C) 45° (D) 60°

13. The height y and distance x along the horizontal for a body projected in the vertical plane are given by $y = 8t - 5t^2$ and $x = 6t$. The initial speed of projection is
(A) 8 m/s (B) 9 m/s
(C) 10 m/s (D) (10/3) m/s

14. A particle is projected horizontally in air at a height of 25 m from the ground with a speed of 10 m/s. The speed of the particle after 2 seconds will be

(A) 10 m/s (B) 22.4 m/s
(C) 25 m/s (D) 28.4 m/s

15. In the above question the particle will hit the ground after a time
(A) 1.7 s (B) 2.5 s
(C) 2.2 s (D) 3s.

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ANSWER KEY

ADVANCE LEVEL - I

1. 50 m
2. 54 m
3. $\frac{a}{2q}\sqrt{P^2+1}$
4. 2 m
5. 6 m/s
6. 5 km/hr, 53° North of East.
7. 54 m
9. 4 sec
10. $\frac{2v_o(v_1+v_2)}{2v_o+v_1+v_2}$
11. $3\sqrt{2}$ km/hr at 45° with the vertical
12. 2.832 m/s at an angle of 32° with $\overrightarrow{V_B}$
13. (A) 40 sec; (B) 80 m
14. 3.333 km
15. $\frac{u}{g\sin\theta}$

ADVANCE LEVEL – II

1. 2d/3v
2. (A) 82 m; (B) 90 m/s
3. 0.1 m/s^2
4. CD = $\frac{\ell}{\sqrt{n^2-1}}$
5. (a) $\sin^{-1}\left(\frac{3}{5}\right)$ from the line normal to the bank, (b) 2 min 40 sec.
6. 2.5 m
7. (a) 10m/s, (b) 2sec, (c) 5m, (d) 16.25 m, (e) 20 m
8. (A)$\sin^{-1}\frac{1}{15}$ east of line AB; (B) 50 minute
9. $\frac{v\ell}{v^2-u^2}$
10. 20 km/hr at an angle $\tan^{-1}\frac{3}{4}$ or 37° east of north, 1.39 km
12. (A) $\frac{1}{2}\alpha^2 t; \frac{\alpha^2}{2}$ (B) $\frac{1}{2}\alpha\sqrt{s}$
13. $\sqrt{\frac{gR\left(1+3\sin^2\beta\right)}{2\sin\beta}}$
14. (A) 23.32 km/hr, 59° South of West, (B) 25.61 km/hr, 51.34° North of East
15. $\frac{u^2\cos^2\theta}{g\cos^3\frac{\theta}{2}}$

MAINS LEVEL - I

1. (D)
2. (B)
3. (C)
4. (B)
5. (C)
6. (B), (D)
7. (A)
8. (B)
9. (A)
10. (C)
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MAINS LEVEL - II

1. (C)
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