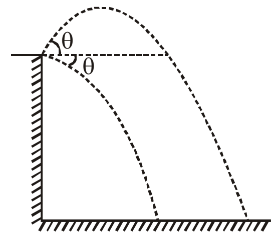
GUIDED REVISION

SECTION-I

Single Correct Answer Type **9 Q. [3 M (–1)]**

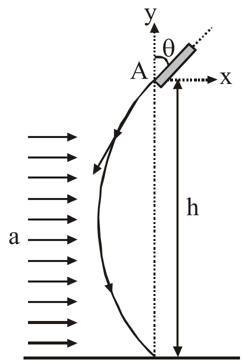
1. Two balls are thrown with the same speed v_0 from the top of a cliff. The angles of their initial velocities are θ above and below the horizontal, as shown. How much farther along the ground does the top ball hit than the bottom ball :-



(A) $\dfrac{2v_0^2 \sin^2\theta\cos^2\theta}{g}$ (B) $\dfrac{2v_0^2 \sin\theta}{g}$

(C) $\dfrac{2v_0^2 \cos\theta}{g}$ (D) $\dfrac{2v_0^2 \sin\theta\cos\theta}{g}$

2. A particle is ejected from the tube at A with a velocity v at an angle θ with the vertical y–axis. A strong horizontal wind gives the particle a constant horizontal acceleration a in the x–directions. If the particle strikes the ground at a point directly under its released position and the downward y–acceleration is taken as g then



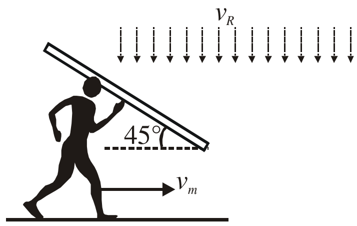
(A) $h = \dfrac{2v^2 \sin\theta\cos\theta}{a}$

(B) $h = \dfrac{2v^2 \sin\theta\cos\theta}{g}$

(C) $h = \dfrac{2v^2}{g}\sin\theta\left(\cos\theta + \dfrac{a}{g}\sin\theta\right)$

(D) $h = \dfrac{2v^2}{a}\sin\theta\left(\cos\theta + \dfrac{g}{a}\sin\theta\right)$

3. On a particular day rain drops are falling vertically at a speed of 5 m/s. A man holding a plastic board is running to escape from rain as shown. The lower end of board is at a height half that of man and the board makes 45° with horizontal. The maximum speed of man so that his feet does not get wet, is



(A) 5 m/s (B) $5\sqrt{2}$ m/s (C) $5/\sqrt{2}$ m/s (D) zero

4. Two trucks are moving on parallel tracks. A person on one truck projects a ball vertically upward then path of the ball as seen by four observers: from the ground, from the second truck moving with same velocity as that first truck, from the second truck moving with speed greater than first one in same direction and from the second truck moving with speed less than the first truck in same direction are:

(A) Parabola, Parabola, Parabola and Parabola

(B) Straight line, Straight line, Parabola and Parabola

(C) Parabola, Straight line, Parabola and Parabola

(D) None of these

5. Man A sitting in a car moving at 54 km/hr observes a man B in front of the car crossing perpendicularly the road of width 15 m in three seconds. Then the velocity of man B will be

(A) $5\sqrt{10}$ towards the car (B) $5\sqrt{10}$ away from the car

(C) 5 m/s perpendicular to the road (D) None

6. A boatman moves his boat with a velocity 'v' (relative to water) in river and finds to his surprise that velocity of river 'u' (with respect to ground) is more than 'v'. He has to reach a point directly opposite to the starting point on another bank by travelling minimum possible distance. Then

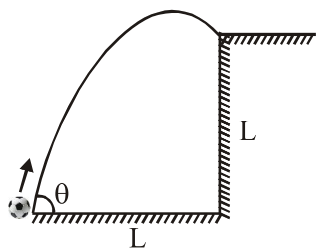
(A) he must steer the boat (with velocity v) at certain angle with river flow so that he can reach the opposite point on other bank directly.

(B) his velocity 'v' must be towards directly opposite point, So, that he can travel rest of distance by walking on other bank to reach the directly opposite point.

(C) boatman should maintain velocity v of boat at certain angle greater than 90° with direction of river flow to minimize drifting and then walk rest of distance on other bank.

(D) boat velocity 'v' should be at an angle less than 90° with direction of river flow to minimize the drift and then walk to the point.

7. A ball is thrown at an angle θ up to the top of a cliff of height L, from a point at a distance L from the base, as shown in figure. Assuming that one of the following quantities is the initial speed required to make the ball hit right at the edge of the cliff, which one is it :-

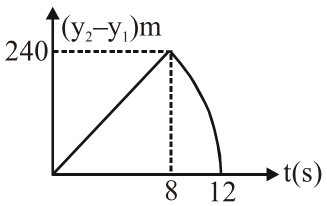


(A) $\sqrt{\dfrac{gL}{2(\tan\theta-1)}}$ (B) $\dfrac{1}{\cos\theta}\sqrt{\dfrac{gL}{2(\tan\theta-1)}}$ (C) $\dfrac{1}{\cos\theta}\sqrt{\dfrac{gL}{2(\tan\theta+1)}}$ (D) $\sqrt{\dfrac{gL\tan\theta}{2(\tan\theta+1)}}$

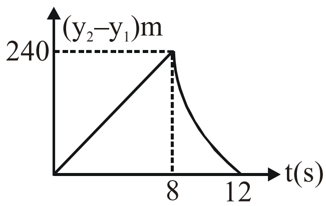
8. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first ?

(Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10\ m/s^2$) *(The figure are schematic and not drawn to scale)* **[JEE Main-2015]**

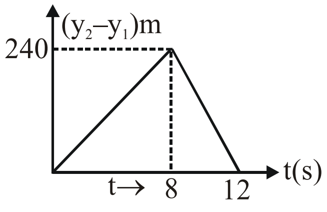
(A)



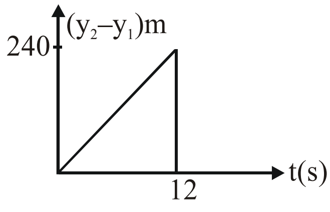
(B)



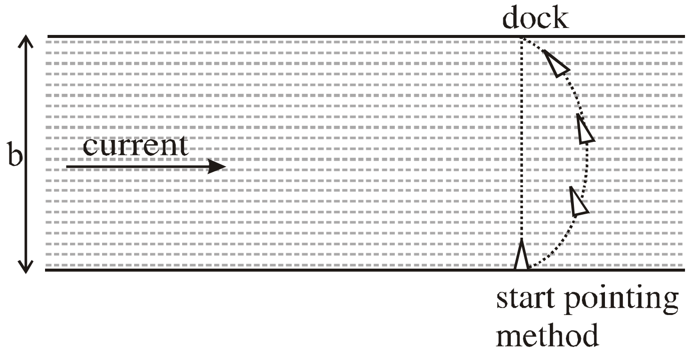
(C)



(D)



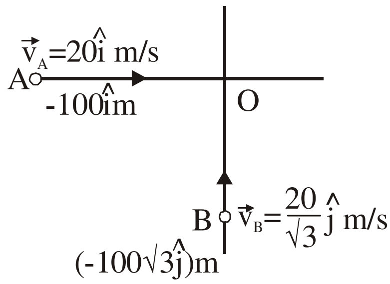
9. Suppose you are anchored near the shore of a channel in which there is steady current, and you are going to run your (motor) boat at constant throttle to a dock directly across the channel on the opposite shore. The way in which one might steer the boat to the dock is POINTING method. In pointing method keep the nose of the boat pointed directly at the dock. Velocity of boat with respect to water is 'v' and velocity of water is 'u'. Width of water channel is 'b'. The time taken by boat to reach the dock is :-



(A) $\dfrac{bv}{v^2-u^2}$ (B) $\dfrac{b}{\sqrt{v^2-u^2}}$ (C) $\dfrac{bu}{v^2}$ (D) $\dfrac{bv}{u^2}$

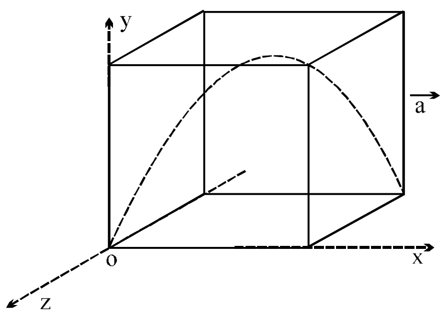
Multiple Correct Answer Type 2 Q. [4 M (–1)]

10. Positions of two vehicles A and B with reference to origin O and their velocities are as shown.



(A) they will collide
(B) distance of closest approach is 100 m.
(C) their relative speed is $\dfrac{40}{\sqrt{3}}$ m/s
(D) their relative velocity is $\dfrac{20}{\sqrt{3}}$ m/s

11. A cubical box dimension L = 5/4 metre starts moving with an acceleration $\vec{a} = 0.5\ m/s^2\ \hat{i}$ from the state of rest. At the same time, a stone is thrown from the origin with velocity $\vec{V} = v_1\hat{i} + v_2\hat{j} - v_3\hat{k}$ with respect to earth. Acceleration due to gravity $\vec{g} = 10 m/s^2(-\hat{j})$. The stone just touches the roof of box and finally falls at the diagonally opposite point then :

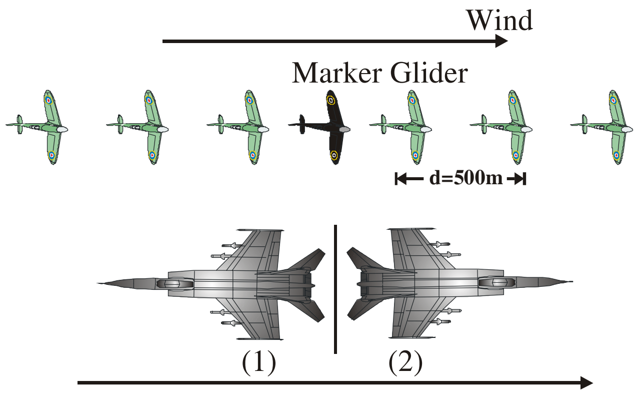


(A) $v_1 = \dfrac{3}{2}$ (B) $v_2 = 5$ (C) $v_3 = \dfrac{5}{4}$ (D) $v_3 = \dfrac{5}{2}$

Linked Comprehension Type **(1 Para × 3Q. & 1 Para × 2Q.) [3 M (-1)]**
(Single Correct Answer Type)

Paragraph for Question no. 12 to 14

In an air show a unique exercise was conducted. A large number of gliders [without engine] were released in a strong horizontal wind that imparts a constant velocity of 5 m/s to the gliders. Gliders are travelling in a straight line with a constant separation between each glider. One of the gliders is painted differently and is referred as marker glider. At t = 0, two airplanes were set to move in opposite direactions, one along the wind and other opposite to the wind. Airplane engines maintain a constant speed of 10 m/s relative to the wind. Planes started from marker glider. After 10 minutes of flying, both the airplanes were signalled by marker glider to return and meet at its position. Ignore the length of airplane and gliders in calculation.



12. Mark the incorrect statement.
(A) Both the planes reach the marker glider simultaneously.
(B) Airplane (1) reaches earlier than other plane
(C) For an observer standing on ground, distance traveled by both the airplanes is same
(D) For an observer on marker glider, distance traveled by each airplanes is same

13. Time takes by airplane (1) to return to marker glider after getting signal.
(A) 10 minutes (B) 15 minutes (C) 20 minutes (D) 25 minutes

14. Mark the correct statement
(A) Number of gliders crossed by airplane (1) is 24
(B) Airplane (1) has crossed more gliders than (2) in entire journey.
(C) Airplane (2) has crossed more gliders than (1) in entire journey.
(D) Number of gliders crossed by airplane 2 is 48

Paragraph for Questions 15 and 16

At t = 0 on the planet "Gravitus Increasicus", a projectile is fired with speed 6 m/s at an angle 30° above the horizontal. This planet is a strange one, in that the acceleration due to gravity increases linearly with time, starting with a value of zero when the projectile is fired. In other words, g(t) = 2t.

15. The time of flight of the projectile is :-
(A) 1 sec (B) 2 sec (C) 3 sec (D) $3\sqrt{3}$ sec

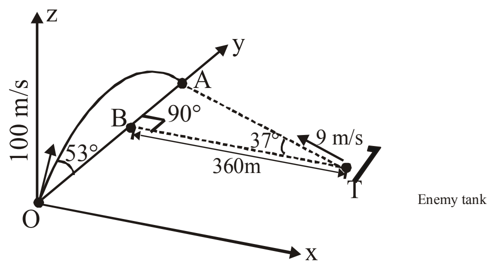
16. Range of the projectile is :-
(A) 9m (B) $\frac{9}{\sqrt{3}}$ m (C) $6\sqrt{3}$ m (D) $9\sqrt{3}$ m

SECTION-II

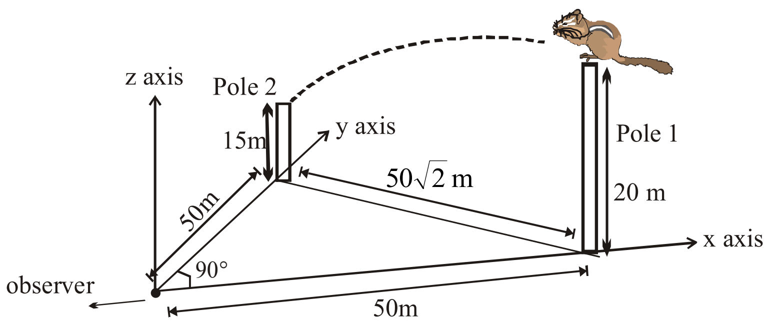
Numerical Answer Type Question **3 Q. [3(0)]**

(upto second decimal place)

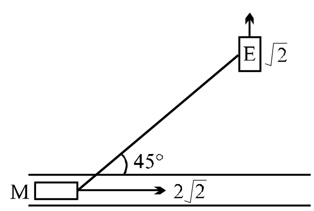
1. A tank is initially at a perpendicular distance BT = 360 m from the plane of firing as shown. The enemy tank is moving with a speed of 9 m/s in direction TA as shown in figure. A gun can fire shell in y-z plane only with a speed 100 m/s at an angle of 53° such that the shell lands at points A. If tank started at t = 0 then time interval (in sec) after which shell is to be fired to hit the tank is



2. A small squirrel jumps from pole 1 to pole 2 in horizontal direction. Squirrels is observed by a very small observer at origin. What is average velocity vector of squirrel ? If average velocity vector is expressed as $v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$, express your answer as sum of magnitudes of its components $|v_x| + |v_y| + |v_z|$ in unit m/s.



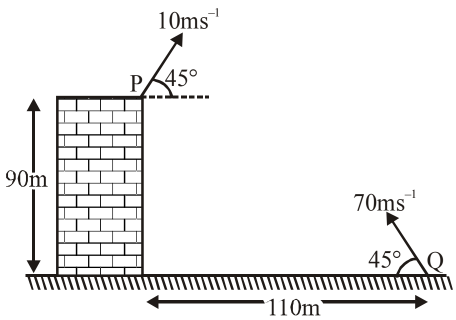
3. A bow man is riding on a horse moving with speed of $2\sqrt{2}$ ms^{-1} along a straight road. He aims at his enemy moving perpendicularly to the road at speed of $\sqrt{2}$ ms^{-1}. At the instant when he fires the arrow, the line joining man and his enemy makes an angle of 45° with the road. Find the angle with the road at which he should aim to hit his enemy? Muzzle velocity of arrow is 5ms^{-1}. (given that sin 37° = 3/5). Neglect effect of gravity.



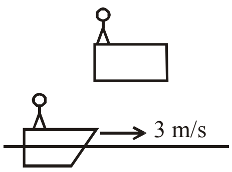
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 3 Q. [4 M (0)]

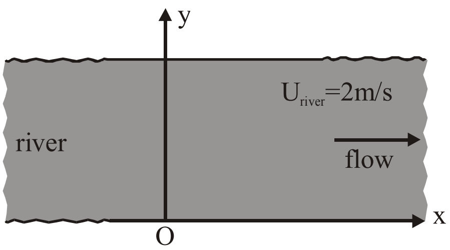
1. Two particles P and Q are launched simultaneously as shown in figure. Find the minimum distance between particles in meters.



2. You are standing on the chambal Bridge watching the boats in the river. You see a motorboat pass directly below you, traveling perpendicular to the bridge at a speed of 3 m/s. A person on the boat throws a baseball at an initial speed of v_0 and at an angle of 37° from the vertical (Note: both v_0 and the angle are with respect to the boat). Find the value of v_0 (in m/s) necessary for the ball to travel straight up towards you.



3. A man can swim in still water with a speed of 3 m/s. x and y axis with respect to ground are drawn along and normal to the bank of river flowing to right with a speed of 2 m/s. The man starts swimming from origin O at t = 0 second. Assume size of man to be negligible. Locus of all the possible points where man can reach at t = 2 sec is $(x - a)^2 + y^2 = c^2$. Find value of $\frac{ac}{4}$.

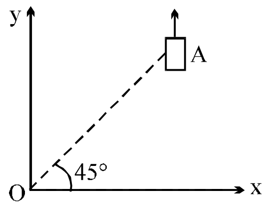


Subjective Type 7 Q. [4 M (0)]

1. On a frictionless horizontal surface, assumed to be the x-y plane, a small trolley. A is moving along a straight line parallel to the y-axis (see figure) with a constant velocity of $(\sqrt{3} - 1)$ m/s. At a particular instant, when the line OA makes an angle of 45° with the x-axis, a ball is thrown along the surface from the origin O. Its velocity makes an angle ϕ with the x-axis and it hits the trolley.

(a) The motion of the ball is observed from the frame of trolley. Calculate the angle θ made by the velocity vector of the ball with the x-axis in this frame.

(b) Find the speed of the ball with respect to the surface, if $\phi = \frac{4\theta}{3}$.

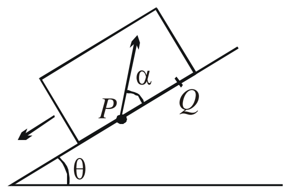


2. A glass wind-screen of adjustable inclination is mounted on a car. The car moves horizontally with a speed of 6 m/s. At what angle α with the vertical should the wind screen be adjusted so that the rain drops falling vertically with 2 m/s strike the wind screen perpendicularly?

3. A large heavy box is sliding without friction down a smooth plane of inclination θ. From a point P on the bottom of the box, a particle is projected inside the box. The initial speed of the particle with respect to box is u and the direction of projection makes an angle α with the bottom as shown in figure. **[JEE]**

(i) Find the distance along the bottom of the box between the point of projection P and the point Q where the particle lands. (Assume that the particle does not hit any other surface of the box. Neglect air resistance).

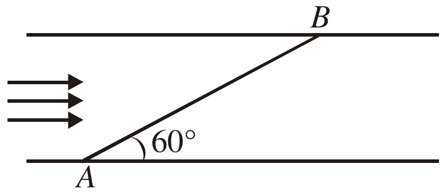
(ii) If the horizontal displacement of the particle as seen by an observer on the ground is zero, find the speed of the box with respect to the ground at the instant when the particle was projected.



4. A swimmer starts to swim from point A to cross a river. He wants to reach point B on the opposite side of the river. The line AB makes an angle 60° with the river flow as shown. The velocity of the swimmer in still water is same as that of the water

(i) In what direction should he try to direct his velocity? Calculate angle between his velocity and river velocity.

(ii) Find the ratio of the time taken to cross the river in this situation to the minimum time in which he can cross this river.



Paragraph for Question no. 5 to 7 : Flag in wind

When you are standstill holding a flag, the flag flutters in the direction of wind. When you start running the direction of fluttering of the flag changes in to the direction of the wind relative to you. In all case a flag flutters in the direction of the wind relative to the flag.

5. When you are standstill holding a flag the flag flutters in the north and when you run at 8 m/s due east, the flag flutters in direction 37° north of west. Find the wind velocity.

6. Wind is blowing uniformly due north everywhere with velocity 12 m/s. A car mounted with a flag starts running towards east. After 9 s from start the flag flutters in 53° north of west and after 16 s from the start the flag flutters in 37° north of west.

(a) Find velocity of the car 9 s after it starts.

(b) Find velocity of the car 16 s after it starts.

(c) If the car maintains uniform acceleration, find acceleration of the car.

7. Holding a flag, when you run at 8 m/s due east, the flag flutters in the north and when you run at 2 m/s due south, the flag flutters in the northeast. If the wind velocity is uniform and remain constant, find the wind velocity.

SECTION-I

Single Correct Answer Type **9 Q. [3 M (–1)]**

1. Ans. (D) **2. Ans. (D)** **3. Ans. (A)** **4. Ans. (C)**
5. Ans. (B) **6. Ans. (C)** **7. Ans. (B)** **8. Ans. (A)**
9. Ans. (A)

Multiple Correct Answer Type **2 Q. [4 M (–1)]**

10. Ans. (B, C) **11. Ans. (A,B,C)**

Linked Comprehension Type **(1 Para × 3Q. & 1 Para × 2Q.) [3 M (-1)]**
(Single Correct Answer Type)

12. Ans. (B) **13. Ans. (A)** **14. Ans. (A)** **15. Ans. (C)**
16. Ans. (D)

SECTION-II

Numerical Answer Type Question **3 Q. [3(0)]**
(upto second decimal place)

1. Ans. 34 **2. Ans.** 105 **3. Ans.** 82°

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **3 Q. [4 M (0)]**

1. Ans. 6 **2. Ans.** 5 **3. Ans. 6**

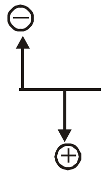
Subjective Type **7 Q. [4 M (0)]**

1. Ans. (a) 45°, (b) 2 m/sec **2. Ans.** $\tan^{-1}(1/3)$ **3. Ans.** (i) $\dfrac{u^2 \sin 2\alpha}{g\cos\theta}$ (ii) $v = \dfrac{u\cos(\alpha+\theta)}{\cos\theta}$
4. Ans. (i) 120° (ii) $2/\sqrt{3}$ **5. Ans.** 6 m/s due north **6. Ans.** (a) 9 m/s (b) 16 m/s (c) 1 m/s^2
7. Ans. 10 m/s, 37° north of east

SECTION-I

Single Correct Answer Type **9 Q. [3 M (–1)]**

1. Ans. (D)



Sol. For upper ball

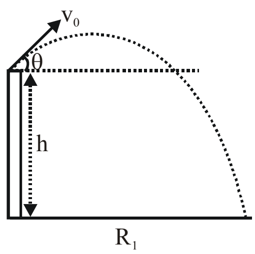
$$h = -v_0\sin\theta\, t_1 + \frac{1}{2}gt_1^2 \quad .....(i)$$

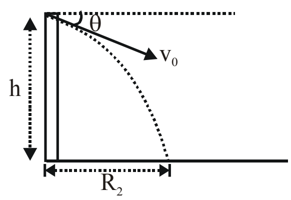
$$R_1 = v_0\cos\theta\, t_1 \quad .....(ii)$$

For lower ball

$$h = v_0\sin\theta\, t_2 + \frac{1}{2}gt_2^2 \quad .....(iii)$$

$$R_2 = v_0\cos\theta\, t_2 \quad .....(iv)$$



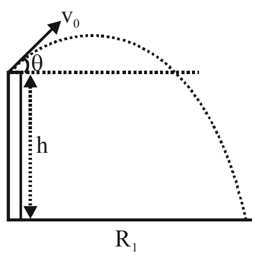


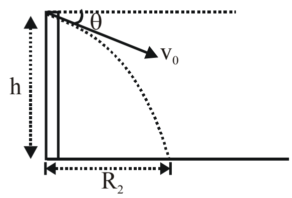
From (i) – (iii)

$$t_1 - t_2 = \frac{2v_0\sin\theta}{g}$$

From (ii) – (iv)

$$R_1 - R_2 = \frac{2v_0^2\sin\theta\cos\theta}{g}$$





2. Ans. (D)

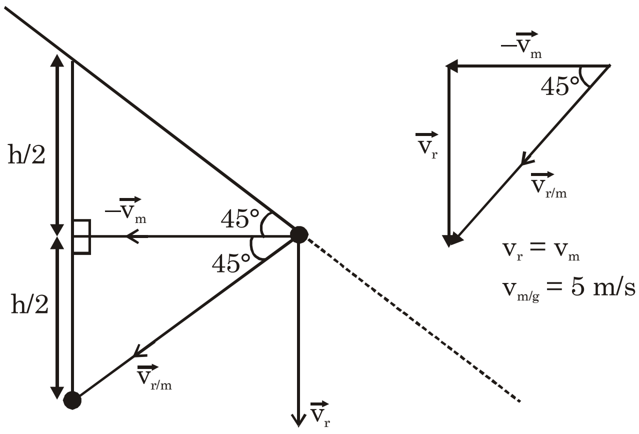
Sol. Displacement along x–axis = 0, $v\sin\theta t - \frac{1}{2}at^2 = 0 \Rightarrow t = \frac{2v\sin\theta}{a}$

Displacement along y–axis = h

$$\&\ h = v\cos\theta t + \frac{1}{2}gt^2 = v\cos\theta\left(\frac{2v\sin\theta}{a}\right) + \frac{1}{2}g\left(\frac{2v\sin\theta}{a}\right)^2 = \frac{2v^2}{a}\sin\theta\left(\cos\theta + \frac{g}{a}\sin\theta\right)$$

3. **Ans. (A)**

Sol.



$v_r = v_m$

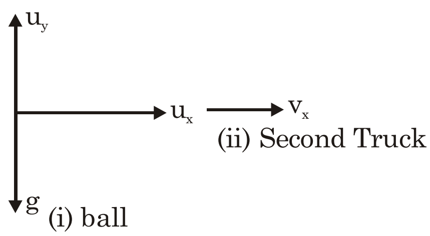
$v_{m/g} = 5$ m/s

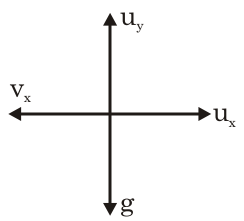
4. **Ans. (C)**

Sol. $\vec{v}_{b/g} = \vec{v}_{b/T} + \vec{v}_{T/g}$

$v_{b/T} = u_y$

$v_{T/g} = u_x$





w.r.t second truck

(T represents truck & b represents ball)

5. **Ans. (B)**

Sol. D = vt

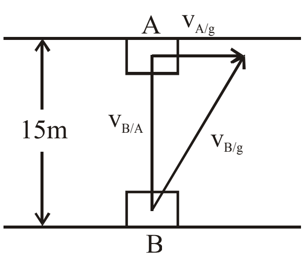
$\frac{15}{3} = v$

$5 = v$

$v_{B/A} = 5$

$v_{A/g} = 15$

$(v_{B/g})^2 = (v_{B/A})^2 + (V_{A/g})^2$

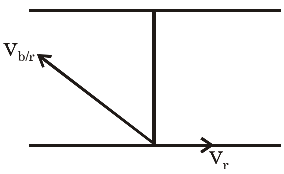


$= \sqrt{(15)^2 + 5^2}$

$= \sqrt{225+25}$ = $\sqrt{250}$ = $5\sqrt{10}$ away from car

6. **Ans. (C)**

Sol.

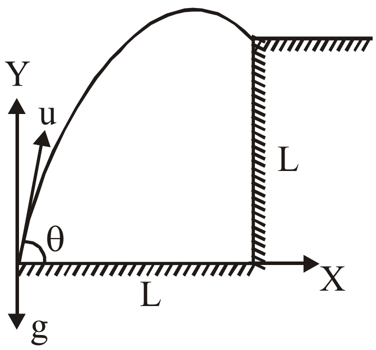


$v_r > v_{b/r}$, so zero drift in not possible.

(C) boatman should be mantain velocity v of boat at certain angle greater than 90° with direction of river flow to minimize drifting & than walk rest of distance on other bank.

7. **Ans. (B)**

Sol.



From equation of tajectory

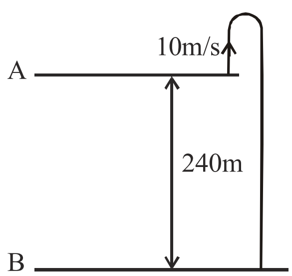
$y = x \tan\theta - \dfrac{gx^2}{2u^2\cos^2\theta}$

Put x = L & y = L

on solving $u = \dfrac{1}{\cos\theta}\sqrt{\dfrac{g\ell}{2(\tan\theta - 1)}}$

8. **Ans. (A)**

Sol. For particle 1

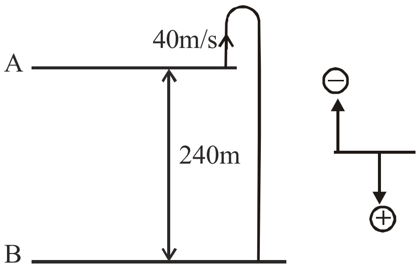


$-240 = +10t - \frac{1}{2}gt^2$

$5t^2 - 10t - 240 = 0$

$t_1 = 8$ sec

For particle 2



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

$5t^2 - 40t - 240 = 0$

$t_2 = 12$ sec

for $0 < t < 8$ sec $\rightarrow$ $a_{rel} = 0$

straight line x-t graph

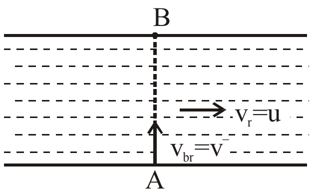
for $8 < t < 12$ sec $\rightarrow a_{rel} = -g$

downward parabola

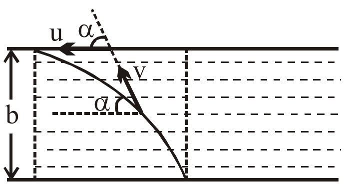
for $t > 12$ sec $\rightarrow$ Both particles comes to rest

9. **Ans. (A)**

Sol.



In the river frame dock will move towards left with speed u



$$ut_0 = v\int_0^{t_0} \cos\alpha\, dt \qquad \text{... (1)}$$

$$v - u\cos\alpha = -\frac{ds_{rel}}{dt}$$

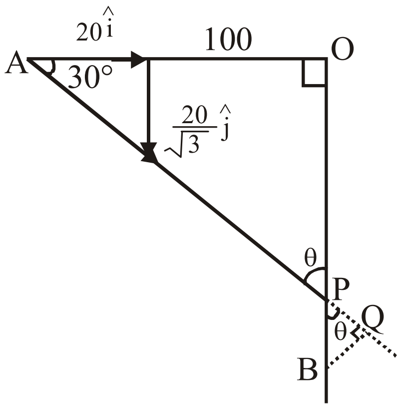
$$\int_0^{t_0}(v-u\cos\alpha)dt=\int_b^0 -ds_{rel} \qquad \ldots (2)$$

$$vt_0-\frac{u^2t_0}{v}=b\ ,\ t=\frac{bv}{v^2-u^2}$$

Multiple Correct Answer Type 2 Q. [4 M (–1)]

10. Ans. (B, C)

Sol. In frame of B



$$\vec{v}_{A/B}=20\hat{i}-\frac{20}{\sqrt{3}}\hat{j}$$

$$|\vec{v}_{A/B}|=\frac{40}{\sqrt{3}}m/s$$

$$\frac{OP}{100}=\tan 30=\frac{1}{\sqrt{3}}$$

$$OP=\frac{100}{\sqrt{3}}$$

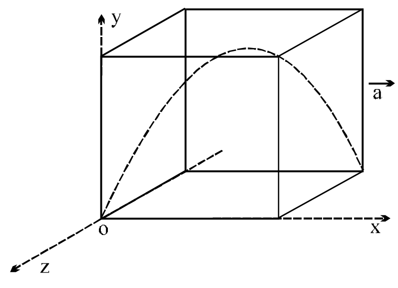
Minimum distance $\perp$ = BQ = BP sin θ

$$BP=\frac{200}{\sqrt{3}}\ ;\ \theta=60°$$

In frame of B velocity of A is not along B, so they does not collide.

11. Ans. (A,B,C)

Sol. $H=\frac{u_y^2}{2g}\Rightarrow\ \frac{5}{4}=\frac{u_y^2}{2\times10}$, $u_y=5m/s$



$$T=\frac{2u_y}{g}=1\text{ sec}$$

$x=u_x\times t-\frac{1}{2}a\times t^2$ (as $\vec{a}$ in $\times$ direction)

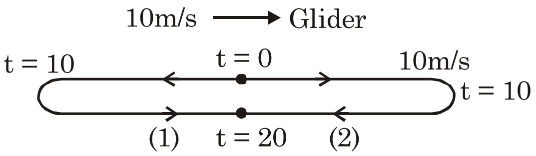
$\frac{5}{4}=u_x\times1-\frac{1}{2}\times(0.5)\times1^2$ $u_x=3/2$ m/sec

Along z axis $\frac{5}{2}=v_2\times1\Rightarrow v_2=5/4$ m/sec

Linked Comprehension Type (1 Para × 3Q. & 1 Para × 2Q.) [3 M (-1)]
(Single Correct Answer Type)

12. Ans. (B)

Sol. Solve problem in the frame of glider. In glider frame speed of both air plane with be same.



in 10 minutes they with cover equal distance in glider frame & now they return to marker glider in next 10 minutes. (A) Option in correct & (B) is wrong (C) distance travelled for an observer in ground for airplane 1 & 2

$d_1 = (10 - 5) \times 600 + (10 + 5) \times 600$

$d_2 = (10 + 5) \times 600 + (10 - 5) \times 600$

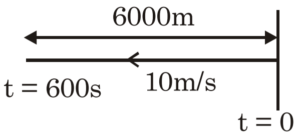
d_1 & d_2 are equal

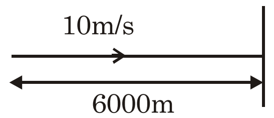
(d) for an observer on marker glider.

$d_1 = 10 \times 600 + 10 \times 600$, $d_2 = 10 \times 600 + 10 \times 600$

13. Ans. (A)

Sol. W.R.T. glider





$$t = \frac{6000}{10} = 600\,\text{sec} = 10\,\text{min}$$

14. Ans. (A)

Sol. No. of glider crossed for forward Journey

$$N_1 = \frac{6000}{500} = 12$$

No. of glider crossed for backward joruney

$$N_2 = \frac{6000}{500} = 12$$

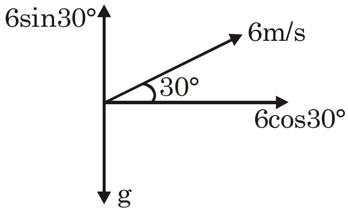
$N = N_1 + N_2 = 24$

15. Ans. (C)

16. Ans. (D)

Sol. (15 & 16)

$a = \frac{dv}{dt} = -2t$



$v = -t^2 + 3$

$s = 3t - \frac{t^3}{3}$

when particle returns to ground

$s = 0,\ -\frac{t^3}{3} + 3t = 0, t = 3s$

So time of flight = 3s

Range = 6 cos 30° × 3 = $9\sqrt{3}$

SECTION-II

Numerical Answer Type Question 3 Q. [3(0)]

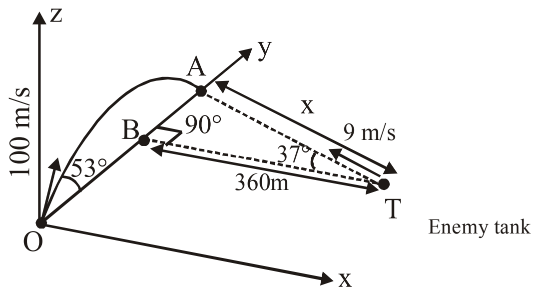
(upto second decimal place)

1. Ans. 34

Sol. $t_T = \frac{360 \times 50}{9 \times \cos 37°} = 50;\ \ t_f = \frac{2 \times 100 \times 4/5}{10} = 16 \text{ sec}$

Time taken to shell reach ground again is

$0 = 100 \sin 53° t - \frac{1}{2} \times 10 \times t^2$



$t = \frac{2 \times 100 \times \sin 53°}{g}$

t = 16 sec

x cos37° = 360

$x = \frac{5 \times 360}{4} = 450$ m

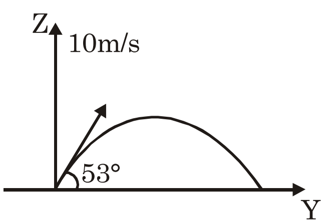
Time taken to reach enemy tank to A

$t = \frac{450}{9} = 50$ sec

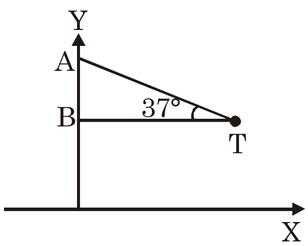
So after time shell should fine = 50 – 16 = 34 sec.

2. Ans. 0105

Sol.

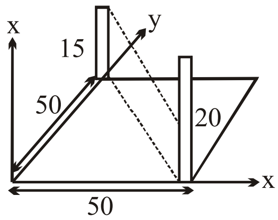


YZ plane is vertical plane



XY plane is horizontal plane

$$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times5}{10}} = 1 \text{ s}$$



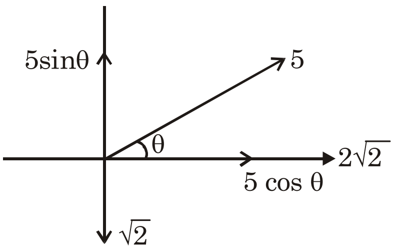
$$v_x = \frac{x}{t} = \frac{50}{1} = 50 \text{ m/s}$$

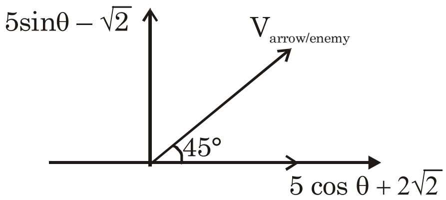
$$v_y = \frac{y}{t} = \frac{50}{1} = 50 \text{ m/s}$$

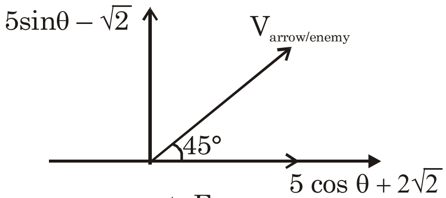
$$v_z = \frac{z}{t} = \frac{5}{1} = 5 \text{ m/s}$$

3. **Ans.** 82°

Sol.







w.r.t. Enemy

$$5\cos\theta + 2\sqrt{2} = 5\sin\theta - \sqrt{2}$$

$$5\sin\theta - 5\cos\theta = 3\sqrt{2}$$

$$\frac{1}{\sqrt{2}}\sin\theta - \frac{1}{\sqrt{2}}\cos\theta = \frac{3}{5}$$

$$\sin(\theta - 45) = \sin 37°$$

$$\theta = 45° + 37°$$

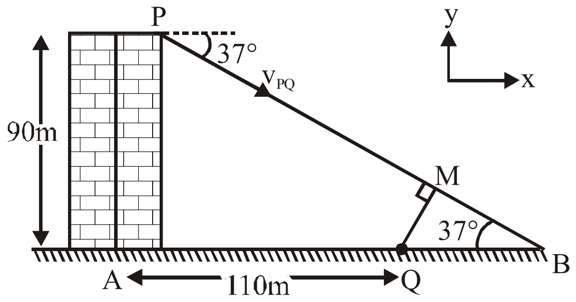
$$\theta = 82°$$

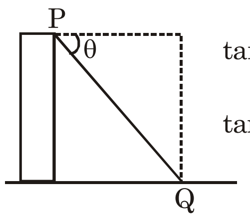
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 3 Q. [4 M (0)]

1. Ans. 6

Sol.



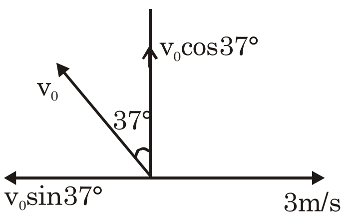


$$\vec{v}_{PQ} = \vec{v}_P - \vec{v}_Q = \left(\frac{10}{\sqrt{2}}\hat{i} + \frac{10}{\sqrt{2}}\hat{j}\right) - \left(-\frac{70}{\sqrt{2}}\hat{i} + \frac{70}{\sqrt{2}}\hat{j}\right) = 40\sqrt{2}\,\hat{i} - 30\sqrt{2}\,\hat{j}$$

Δ PAB, $\tan 37^\circ = 50/AB$ $AB = 90 \times \frac{4}{3} = 120m \Rightarrow QB = 10m \Rightarrow QM = 10\sin 37^\circ = 10 \times \frac{3}{5} = 6m$

2. Ans. 5

Sol.



$v_{ball/g} = v_{ball/boat} + v_{boat/g}$

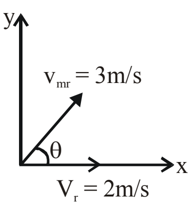
In horizontal direction velocity of ball w.r.t. ground = 0

$v_0 \sin 37^\circ = 3$

$v_0 = 3 \times \frac{5}{3} = 5$ m/s

3. Ans. 6

Sol.



$x = (2 + 3\cos\theta) \times 2$

$y = (3\sin\theta) \times 2$

$\Rightarrow (x - 4)^2 + y^2 = (6)^2$

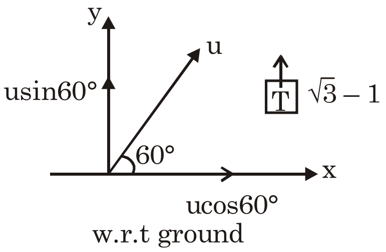
Subjective Type **7 Q. [4 M (0)]**

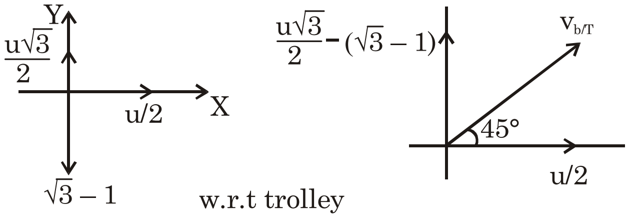
1. **Ans.** (a) 45°, (b) 2 m/sec

Sol. (a) From the frame of trolley ball will appear to move along the line journing origin and trolley

$\therefore \quad \theta = 45°$

(b) In ground frame $\phi = 4\theta/3 = 60°$





$$\frac{u}{2} = \frac{u\sqrt{3}}{2} - \left(\sqrt{3} - 1\right)$$

$$\sqrt{3} - 1 = \frac{u}{2}\left(\sqrt{3} - 1\right)$$

$u = 2$

2. **Ans.** $\tan^{-1}(1/3)$

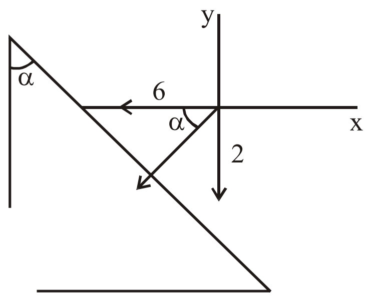
Sol. $\vec{v}_{a/g} = 6\hat{i}$

$\vec{v}_{r/a} = -2\hat{j}$

$v_{r/c} = -6\hat{i} - 2\hat{j}$

$\tan\alpha = \frac{2}{6}$

$\alpha = \tan^{-1}\left(\frac{1}{3}\right)$



3. **Ans.** (i) $\frac{u^2 \sin 2\alpha}{g\cos\theta}$ (ii) $v = \frac{u\cos(\alpha+\theta)}{\cos\theta}$

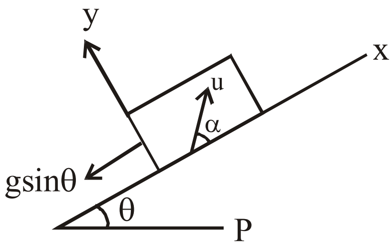
Sol. (i) box is sliding without friction, so acceleration of block will be g sin θ

$\vec{u}_{p/b} = u\cos\alpha\hat{i} + u\sin\alpha\hat{j}$

$\vec{a}_{P/G} = -g\sin\theta\hat{i} - g\cos\theta\hat{j}$

$\vec{a}_{B/G} = -g\sin\theta\hat{i}$

$\vec{a}_{P/B} = \vec{a}_{P/G} - \vec{a}_{b/G} = -g\cos\theta\hat{j}$



So there no acceleration in x-direction in box frame , so velocity will be constant in x-direction.
For time to hetting ground
On y-axis

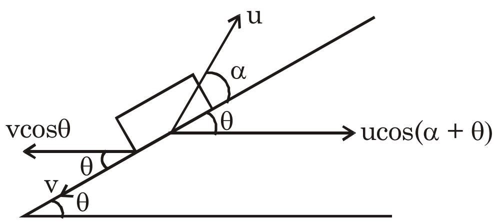
$$S = ut + \frac{1}{2}at^2$$

$$O = u\sin\alpha t - \frac{1}{2}g\cos\theta t^2$$

$$t = \frac{2u\sin\alpha}{g\cos\theta}$$

Distance between P & Q on x-axis

$$S = ut = u\cos\alpha\left(\frac{2u\sin\alpha}{g\cos\theta}\right) = \frac{u^2\sin 2\alpha}{g\cos\theta}$$

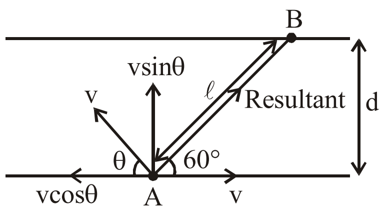
(ii) 

In horizontal direction there is no acceleration. So velocity in horizontal direction will remain constant and as per given in question there is no displacement in x-direction so velocity in x-direction will be zero. $u\cos(\alpha + \theta) - v\cos\theta = 0$

$$v = \frac{u\cos(\alpha+\theta)}{\cos\theta}$$

4. **Ans**. (i) 120° (ii) $2/\sqrt{3}$

Sol. (i) $\dfrac{v\sin\theta}{v - v\cos\theta} = \tan 60° = \sqrt{3}$



$\sin\theta + \sqrt{3}\cos\theta = \sqrt{3}$

$\theta = 60°$

So from direction of flow angle = 120°
For time taken in this situation

$$t_1 = \frac{d}{v\sin 60°} = \frac{2d}{v\sqrt{3}}$$

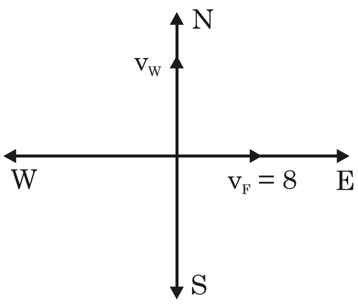
$$t_1 = \frac{2d}{\sqrt{3}v}$$

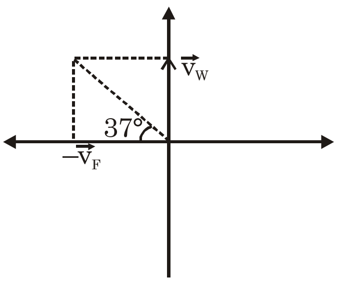
minimum time to cross the river t_2 = d/v

ratio = $\frac{2}{\sqrt{3}}$

5. **Ans.** 6 m/s due north

Sol. When standstill, the flag flutters in north, it means wind velocity is along north
When running 8 m/s due east.





$$\vec{v}_{W/F} = \vec{v}_W - \vec{v}_F$$

Flag flutters 37° north of west

$$\tan 37° = \frac{v_W}{8}$$

v_W = 6 cm/s due north

6. **Ans.** (a) 9 m/s (b) 16 m/s (c) 1 m/s^2

Sol. V_{wind} = 12 m/s due north

Sol. (a) At t = 9 sec

$$\tan 53° = \frac{V_{wind}}{V_{car}}$$

$$V_{car} = \frac{12}{(4/3)}$$

V_{car} = 9 m/s

(b) At t = 16 s

$$\tan 37° = \frac{12}{V_{car}}$$

V_{car} = 16 m/s

(c) $a = \frac{16-9}{7}$ = 1 m/s^2

7. **Ans.** 10 m/s, 37° north of east

Sol. V_m = 8m/s due east

flag fluttering due north

Component of wind velocity in east direction = 8 m/s

Another component towards north = V(say)

V_m = 2 m/s due south

flag flutters due north-east

V_{flag} = (V+2) m/s due north.

8 m/s due east

$$\tan 45^\circ = \frac{(V+2)}{8}$$

v = 6 m/s

$$V_W = \sqrt{6^2 + 8^2}$$

= 10 m/s

Direction 37° worth of east.