doubtnut
India's Number 1 Education App

PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

RELATIVE MOTION

Solved Example

1. The rain is falling vertically downward with velocity $6m/s$ and a man is moving

horizontally with velocity $8m/s$. Find the velocity of rain with respect to the man.

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2. From a light-house an observer two ships A and B. Ship A proceeding towards north at a speed $20\sqrt{2}km/h$ and ship B proceeding towards north-east at a speed of $20km/h$. Find in which direction and at what speed the ship B would appear to move to an observer standing on the deck of the ship A.

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3. A man is walking due west with a velocity $3km/h$ and rain appears to be falling vertically with a velocity $4km/h$. Find the velocity of rain with respect to the ground.

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4. A person travelling east wards at the rate of $4kmh^{-1}$ finds that the wind seems to blow directly from the north . On doubling its

speed, the wind appears to come from 45° north of east. Find the actual velocity of the wind.

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5. A man running on a horizontal road at $6km/h$ finds the rain falling vertically. He doubles his speed and find that the raindrops make an angle 37° with the vertical. Find the velocity of rain with respect to the ground.

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6. Two cars A and B are running with same speed v. A along east and B towards north. Car A is at origin O and B is at distance d as shown. After how much time, the distance between cars is minimum and what is the minimum distance?

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7. Two straight roads meet an angle of 60°. Initially one man is at a distance of $10m$ on

one road from the crossing and the other at a distance of $20m$ on the other road from the crossing. They starts moving at the same instant with the same speed towards the crossing. find the minimum distance between them.

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8. Two particles, 1 and 2, move with constant velocities v_1 and v_2 along two mutually perpendicular straight lines toward the

intersection point O. At the moment $t = 0$ the particles were located at the distances l_1 and l_2 from the point O. How soon will the distance between the particles become the smallest? What is it equal to?

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9. Three particles A, B and C are situated at the vertices of an equilateral triangle ABC of side d at time $t = 0$. 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 particles meet each other?

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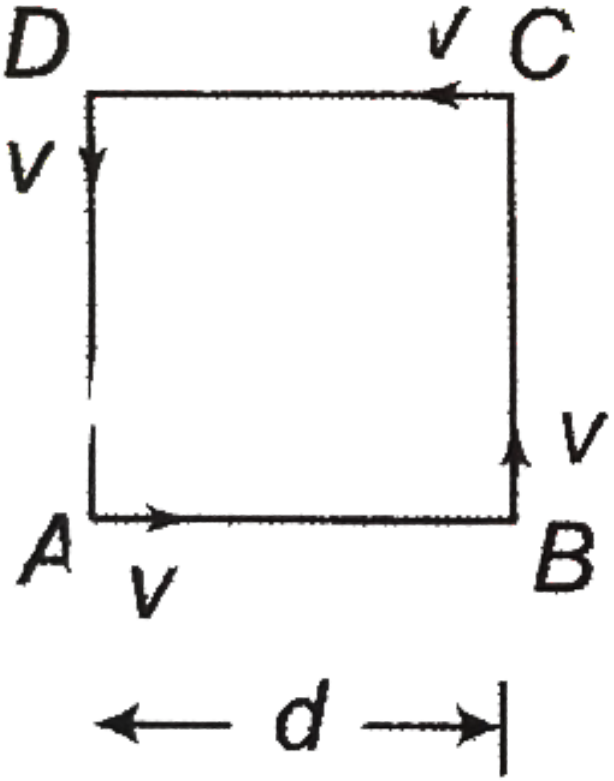
10. Repeat the previous problem in the following cases:



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11. A motorboat coverse a distance between two points in $4h$ along the flow and in $8h$ opposite to the flow. In how much time, distance can be covered in still water?

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12. A motorboat going downstream overcome a raft at a point A, $\tau = 60 \text{ min}$ later it turned back and after some time passed the raft at a distance $l = 6.0km$ from the point A. Find the

flow velocity assuming the duty of the engine to be constant.

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13. A man can swim in still water with speed v. He wants to cross a river of width d that flows with speed u and reaches the point directely opposite to his starting point. (a) In which direction should he try to swim (i.e., find the angle the makes with the river flow)? (b) much time will he take to cross the river ?

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14. In the previous problem, the man wants to cross the river in the minimum time. In which directions, he should move? Find the minimum time to cross the river and his displacement (drift) along the flow.

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15. If $v = \frac{u}{2}$, in which direction the man should swim so that his drift along the flow is

minimum and find value of the minimum drift.

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16. Two boats, A and B, move away from a point P at the middle of a river along the mutually perpendicular straight lines. Boat A moves along the river and boat B across the river. Having moved off equal distance from point P the boats returned. find the ratio of times of motion of boats $\frac{t_A}{t_B}$ if $v = \eta u (\eta > 1)$

. (v : velocity of boat with respect to water. u: stream velocity)

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17. Two swimmers leave point A on one bank of the river to reach point B lying right across on the other bank. One of them crosses the river along the straight line AB while the other swims at right angles to the stream and them walks the distance that he has been carried by the stream to get to point B. what

was the velocity v_0 of his walking if both swimmers reach the destination simultaneously? The stream velocity is u and v is the velocity of swimmer in still water.

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18. A man can swim at a speed of $5km/h$ in the still water. He wants to cross a $1600m$ wide river flowing at $4km/h$. He keeps himself at an angle 127° with the river flow while swimming. (a) Find the time he takes to cross the river. (b)

Find the distance traveled by him along the flow.

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19. An aeroplane has to go from a point O to another point A, at distance d due 37° east of north. A wind is blowing due north at a speed of $20m/s$. The air speed of the plane is v. (a) Find the direction in whihc the pilot should head the plane to reach the point A. (b) Find

the time taken by the plane to go from O to A

.

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20. Two particles start simulataneously from the same point and moves along two straight lines inclined at angle α, one with uniform velocity v_0 and other from the rest with uniform acceleration, a_0. After how much time their relative velocity is minimum and what is it equal to?

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21. Two trains A and B of length $100m$ and $200m$, respectively, are approaching each other on parallel tracks. If they take $15s$ to pass each other and velocity of A is three that of B, find their velocities.

A. 5,15

B. 30,10

C. 12,4

D. 15,5

Answer: D

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22. In how much time trains will pass each other if they are moving in the same direction.

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23. A car travelling at $72km/h$ overtakes another car traveling at $54km/h$. Assuming each car to be $5.0m$ long, find the time taken

during overtake and the total road distance used for the overtake.

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24. The driver of a train moving at a speed v_1 sights another train at a disane d, ahead of him moving in the same direction with a slower speed v_2. He applies the brakes and gives a constant teradation a to his train. Show that here will be no collision if $d > (v_1 - v_2)^2 / 2a$.

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25. Two trucks are moving in a straight line towards each other at initial velocities u_1 and u_2 and with constant retardations a_1 and a_2. If the initial separation between them is d, find the minimum value of d for no collision.

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26. A car 2m long and 3m wide is moving at $10m/s$ when a bullet hits it in a direction

making an angle of $\tan^{-1}(3/4)$ with the car as seen from the ground. The bullet enters one edge of the car at the corner and passes out at diagonally opposite corner. Neglecting gravity, the time for the bullet to cross the car is

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27. A gun is fired from a moving platform and ranges of the shot are observed to be R_1 and R_2 when the platform is moving

forwards and backwards, respectively, with velocity v_P. Find the elevation of the gun $\propto$ in terms of the given quantities.

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Exercise

1. A 120 m long train is moving in a direction with speed 20 m/s . A traing B moving with 30 m/s in the opposite direction and 130 m long crosses the first train in a time

A. $6s$

B. $36s$

C. $38s$

D. None of these

Answer: D

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2. Two trains are moving with equal speed in opposite directions along two parallel railway tracks. If the wind is blowing with speed u

along the track so that the relative velocities of the trains with respect to the wind are in the ratio $1:2,$ then the speed of each train must be

A. $3u$

B. $2u$

C. $5u$

D. $4u$

Answer: A

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

A. $30s$

B. $15s$

C. $8s$

D. $10s$

Answer: D

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4. Two cars are moving in the same direction with the same speed $30km/hr$. They are separated by a distance of $5km$, the speed of a car moving in the opposite direction of it meets these two cars at an interval of 4 minutes, will be.

A. $40km/h$

B. $45km/h$

C. $30km/h$

D. $15km/h$

Answer: B

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5. An express train is moving with a velocity v_1. Its driver finds another train is movig on the same track in the same direction with velocity v_2. To escape collision, driver applies a

retardation a on the train. The minimum time of escaping collision be

A. $t = \frac{v_1 - v_2}{a}$

B. $t = \frac{v_1^2 - v_2^2}{2}$

C. None

D. Both

Answer: A

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6. Two car A and B travelling in the same direction with velocities v_1 and $v_2(v_1 > v_2)$. When the car A is at a distance d ahead of the car B, the driver of the car A applied the brake producing a uniform retardation a. There wil be no collision when.

A. $d < \dfrac{(v_1 - v_2)^2}{2a}$

B. $d < \dfrac{(v_1^2 - v_2^2)}{2a}$

C. $d > \dfrac{(v_1 - v_2)^2}{2a}$

D. $d > \dfrac{(v_1^2 - v_2^2)}{2a}$

Answer: C

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7. A ball A is thrown up vertically with a speed u and at the same instant another ball B is released from a height h. At time t, the speed A relative to B is

A. u

B. $2u$

C. $u - gt$

D. $\sqrt{u^2 - gt}$

Answer: A

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8. A car 'A' moves due north at a speed of $40km/hr$, while another 'B' moves due east at a speed of $30km/hr$. Find the velocity of car B relative to car A (both in magnitude and direction).

A. $50km/hNE$

B. $50km/hNW$

C. $50km/h$ at angle $\tan^{-1}(3/4)WofN$

D. $50km/h$ at angle $\tan^{-1}(4/3)WofN$

Answer: C

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9. A car A going north-east at $80km/h$ and another car B is going south-east at $60km/h$. The direction of the velocity of A

relative to B makes an angle with the north equal to:

A. $\tan^{-1}(2/7)$

B. $\tan^{-1}(7/2)$

C. $\tan^{-1}(7)$

D. $\tan^{-1}(1/7)$

Answer: D

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10. Rain is falling vertically downward with velocity $4m/s$. A man is moving horizontally with velocity $3m/s$, the velocity of rain with respect to man is

A. $5m/s$ at an angle $\tan^{-1}(4/3)$ with horizontal

B. $5m/s$ at an angle $\tan^{-1}(3/4)$ with vertical

C. $5m/s$ at an angle $\tan^{-1}(4/3)$ with vertical

D. Both (1) and (2)

Answer: D

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11. Two boys are standing at the ends A and B of a ground, where $AB = a$. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy in a time t, where t is :

A. $\frac{a}{v+v_1}$

B. $\frac{a}{v-v_1}$

C. $\frac{a}{\sqrt{v^2+v_1^2}}$

D. $\frac{a}{\sqrt{v^2-v_1^2}}$

Answer: D

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12. A ship is travelling due east at a speed of $15km/h$. Find the speed of a boat heading

30° east of north if it appears always due north from the ship.

A. $30km/h$

B. $\frac{15\sqrt{3}}{2}km/h$

C. $10\sqrt{3}km/h$

D. $20km/h$

Answer: A

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13. Three particles A, B and C are situated at the vertices of an equilateral triangle ABC of side d at time $t = 0$. 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 particles meet each other?

A. $2d / 3v$

B. $d / 3v$

C. $3d / 2v$

D. $4d/3v$

Answer: A

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14. Four particles A, B, C and D are situated at the cornerst of a square $ABCD$ of side $aatt-0$. Each of particles moves with constant speed (v). A always has its velocity along AB, B along BC, C along CB~ and D

along DA. At what time will these particles meet each other ?

A. $2d/3v$

B. d/v

C. $3d/2v$

D. $4d/3v$

Answer: B

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15. Six particles situated at the corners of a regular hexagon of side a move at a constant speed v. Each particle maintains a direction towards the particle at the next corner. Calculate the time the particles will take to meet each other.

A. $2d/3v$

B. $2d/v$

C. $3d/2v$

D. $4d/3v$

Answer: B

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16. A particle A is at origin and particle B is at distance $y = -d$ at $t = 0$. They move with constant velocity v, A towards positive x-axis and B towards origin. The time at which distance between them is minimum and minimum distance will be

A. $\frac{d}{2v}, d$

B. $\frac{d}{v}, \frac{d}{\sqrt{2}}$

C. $\frac{d}{2v}, \frac{d}{\sqrt{2}}$

D. $\frac{d}{v}, d$

Answer: C

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17. A police jeep is chasing with, velocity of $45km/h$ a thief in another jeep moving with velocity $153km/h$. Police fires a bullet with

muzzle velocity of $180m/s$. The velocity it will strike the car of the thief is.

A. $150m/s$

B. $27m/s$

C. $450m/s$

D. $250m/s$

Answer: A

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18. A cart is moving horizontally along a straight line with constant speed $30ms^{-1}$. A particle is to be fired vertically upwards from the moving cart in such a way that it returns to the cart at the same point from where it was projected after the cart has moved $80m$. At what speed (relative to the cart) must the projectile be fired? (Take $g = 10ms^{-2}$)

A. $10m/s$

B. $10\sqrt{8}m/s$

C. $\frac{40}{3}m/s$

D. $250m/s$

Answer: D

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19. A boat is moving with a velocity $3\hat{i}+4\hat{j}$ with respect to ground. The water in the river is moving with a velocity $-3\hat{i}-4\hat{j}$ with respect to ground. The relative velocity of the boat with respect to water is.

A. $8j$

B. $-6i-8j$

C. $6i+8j$

D. $5\sqrt{2}$

Answer: C

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20. A boat crosses a river with a velocity of $8\frac{km}{h}$. If the resulting velocity of boat is $10\frac{km}{h}$ then the velocity of river water is

A. $12.8km/h$

B. $6km/h$

C. $8km/h$

D. $10km/h$

Answer: B

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21. A man takes $3h$ to cover a certain distance along the flow and takes $6h$ to cover the same

distance opposite to flow. In how much time, he will cross this distance in still water.

A. $3.5h$

B. $4h$

C. $4.5h$

D. $5h$

Answer: B

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22. A river $500m$ wide is flowing at a rate of $4m/s$. A boat is sailing at a velocity of $10m/s$ with respect to the water, in a direction perpendicular to the river. The time taken by the boat to reach the opposite bank

A. $30s$

B. $40s$

C. $50s$

D. $60s$

Answer: C

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23. In the previous problem, the distance travelled by boat along the flow is

A. $50m$

B. $100m$

C. $150m$

D. $200m$

Answer: D

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24. A boat having a speed of $5km/hr.$ in still water, crosses a river of width $1km$ along the shortest possible path in 15 minutes. The speed of the river in $Km/hr.$

A. $1km/h$

B. $3km/h$

C. $4km/h$

D. $5km/h$

Answer: B

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25. A man crosses a $320m$ wide river perpendicular to the current in 4 min. If in still water he can swim with a speed $5/3$ times that of the current, then the speed of the current, in $m/\ \min$ is

A. 30

B. 40

C. 50

D. 60

Answer: D

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26. A man can swim in still water ast a speed of 3 km/h. He wants to cross a river that flows at 2 km/h and reach the point directly oposite to his starting point. A. In which diretionshoeld he try to swim (that is, find the angle his body

makes wilth the river flow)? b. How much time will he take to cross the river if the river is 500 m wide?

A. $\sin^{-1}(2/3)$

B. $\sin^{-1}(2/5)$

C. $\sin^{-1}(3/4)$

D. $\sin^{-1}(3/5)$

Answer: A

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27. A man can swim in still water ast a speed of 3 km/h. He wants to cross a river that flows at 2 km/h and reach the point directly oposite to his starting point. A. In which diretionshoeld he try to swim (that is, find the angle his body makes wilth the river flow)? b. How much time will he take to cross the river if the river is 500 m wide?

A. $6\sqrt{5}min$

B. $3\sqrt{5}min$

C. $2\sqrt{5}min$

D. $5\sqrt{3}min$

Answer: A

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28. A man can swim at a speed of $3kmh^{-1}$ in still water. He wants to cross a $500m$ wide river flowing at $2kmh^{-1}$. He keeps himself always at an angle to 120° with the river flow while swimming.

The time taken to cross the river is.

A. $10/\sqrt{3}min$

B. $20/\sqrt{3}min$

C. $30/\sqrt{3}min$

D. $40/\sqrt{3}min$

Answer: B

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29. In the previous problem, How far from the point directly opposite to the starting point does the man reach the opposite bank

A. $1/6\sqrt{3}km$

B. $2/3\sqrt{3}km$

C. $4/3\sqrt{3}km$

D. $5/\sqrt{3}km$

Answer: A

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30. A person aiming to reach the exactly opposite point on the bank of a stream is swimming with a speed of $0.5\frac{m}{s}$ at an angle

of 120° with the direction of flow of water. The speed of water in the stream is

A. $1m/s$

B. $0.5m/s$

C. $0.25m/s$

D. $0.433m/s$

Answer: C

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31. A river is flowing from west to east with a speed of $5m/\min$. A man can swim in still water with a velocity $10m/\min$. In which direction should the man swim so as to take the shortest possible path to go to the south.

A. 30° with downstream

B. 60° with downstream

C. 120° with downstream

D. South

Answer: C

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32. A river is flowing from east to west at a speed of $5\frac{m}{\min}$. A man on south bank of river, capable of swimming $\frac{10m}{\min}$ ini still water, wants to swim across the river in shortest time. He should swim

A. Due north

B. Due north-east

C. Due north-east with double the speed of river

D. None of these

Answer: A

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33. A man can swim with velocity v relative to water. He has to cross a river of width d flowing with a velocity $u(u > v)$. The distance traveled by man along the flow is x, when he

reaches to opposite bank. For x to be minimum the person should swim at an angle α with the direction of the flow of water, where α is

A. $\sin^{-1}(v/u)$

B. $\sin^{-1}(u/v)$

C. $\frac{\pi}{2} + \sin^{-1}(v/u)$

D. $\frac{\pi}{2} + \sin^{-1}(u/v)$

Answer: C

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