Quiz #2 Ch.#4 T121 Phys101.37-39-v1

Student ID:..... **Student Name:**..... **Section #** .....

Q#1: A stone is thrown horizontally from the top of a 40m high hill. It strikes the ground at an angle of 30 0 degrees as shown in Fig.2. With what speed was it thrown? (A1 49 m/s)

$\frac{v_{fy}}{v_{fx}} = \tan\theta = \tan 30$, $v_{fx} = v_{ix}$

$v_{ix} = \frac{v_{fy}}{\tan 30}$ but $v_{fy}^2 = v_{iy}^2 - 2\times 9.8\times(-40)$

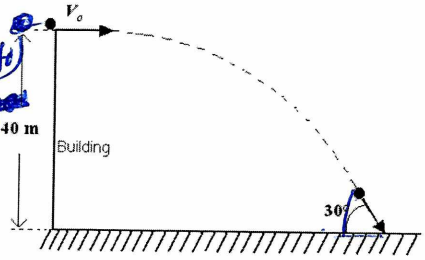
$= +2\times 9.8\times 40$

$v_{fy} = \sqrt{2\times 9.8\times 40}$

$= 28$ m/s.

$v_{ix} = \frac{28}{\tan 30}$

$= 48.5$ m/s.



Q#2: A river has a steady flow of 0.30 m/s. A student swims downstream a distance of 1.2 km and returns to the starting point. If the student can swim at a constant speed of v in still water and the downstream portion of the swim takes him 20 minutes, the time required for the entire swim is: (A1 70 minutes)

downstream $\rightarrow (v_b + v_{riv}) \times t_{down} = 1200 \rightarrow (v_b + 0.3)\times 20\times 60 = 1200$

$v_b + 0.3 = 1 \Rightarrow v_b = 1 - 0.3 = 0.7$ m/s

upstream $(v_b - v_{riv})\, t_{up} = 1200 \Rightarrow (0.7 - 0.3)\times t_{up} = 1200$

$t_{up} = \frac{1200}{0.4} = 3000 = 50$ min $\Rightarrow t_{tot} = t_{up} + t_{down} = 50 + 20 = 70$ min

Q#3: A particle rotates in a horizontal circle of radius 3.5 m. At a given instant, its total acceleration is 2.1 m/s**2 in a direction that makes an angle of 60 to the radial direction (see Figure 3). Determine the speed of the particle, v, at this instant.(A1 1.9 m/s)

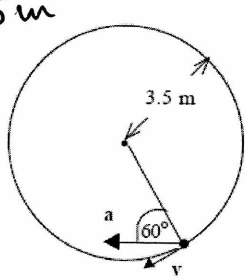
$a_R = a\cos 60^0$, $R = 3.5$ m

but $a_R = \frac{v^2}{R}$.

$v = \sqrt{R a_R} = \sqrt{R\, a \cos 60}$

$= \sqrt{3.5\times 2.1\times \cos 60}$

$v = 1.92$ m/s



Quiz #2 Ch.#4 T121 Phys101.37-39-v2

Student ID:..... **Student Name:**..... **Section #** .....

Q#1 10. A ball is kicked from the ground with an initial speed of 20 m/s at an angle of 45°. A player 60 m away starts running to catch the ball at that instant (see Fig 2). What must be his average speed (v) if he has to catch the ball just before it hits the ground? (A) 6.6 m/s)

Assume boy catches ball at a distance of range R from the starting point

Distance required to be travelled by player = X

$X = 60 - R$

$R = V_{ox} \times 2 \times t_y$ (t_y time for reaching max. height)

$t_y = \frac{V_{oy}}{|g|} = \frac{20 \times \sin 45}{9.8} = 1.44 \text{ sec}$

$V_{player} = \frac{X}{2t_y} = \frac{60 - 20 \times \cos 45 \times 2 \times 1.44}{2 \times 1.44} = \frac{19.2}{2.88} = 6.66 \text{ m/s}$

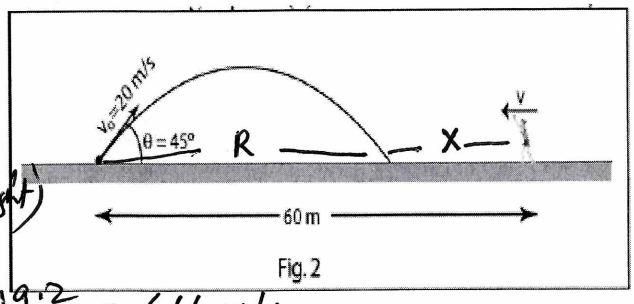


Fig. 2

Q#2: A boat is traveling at 14 km/h in still water (water is not flowing). A man runs directly across the boat, from one side to the other (perpendicular to the direction of motion of the boat), at 6 km/h relative to the boat. The speed of the man relative to the ground is: (A) 15 km/h).

Velocity of boat with respect to water $= \vec{V}_{bw} = \vec{V}_{bg} = 14\hat{i}$ (g means ground)

" " man with respect to boat $= \vec{V}_{mb} = 6\hat{j}$

Velocity of man with respect to ground $= \vec{V}_{mg} = \vec{V}_{mb} + \vec{V}_{bg} = 6\hat{j} + 14\hat{i}$

$|V_{mg}| = \sqrt{6^2 + 14^2} = 15.23 \text{ km/h}$

Q#3 A particle moves with a constant speed along the circumference of a circle of radius 5 m. It completes one revolution every 20 s. What is the magnitude of its average velocity during the first 5 s? Assume that at t = 0, the particle is on +x-ais (see figure 1).(A1 sqrt(2) m/s)

Initial position = (5, 0)

Final position = (0, 5)

The

$V_{avg-x} = \frac{0-5}{5} = -1 \text{ m/s}$

$V_{avg-y} = \frac{5-0}{5} = +1 \text{ m/s}$

$\vec{V}_{avg} = -\hat{i} + \hat{j}$

$|V_{avg}| = \sqrt{1^2 + 1^2} = \sqrt{2}$

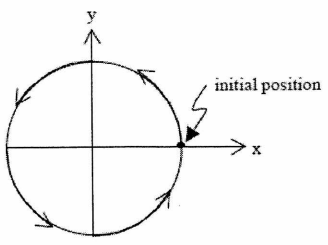


Figure 1

Quiz #2 Ch.#4 T121 Phys101.37-39-v3

Student ID:..... **Student Name:**..... **Section #** .....

Q#1 A rock is projected from ground level as shown in figure 4. Four seconds later the rock is observed to srtike the top of a 10-m tall fence that is a horizontal distance of 75 m from the point of projection. Determine the speed (v0) with which the rock was projected. (A1 29 m/s)

Along x-axis, $v_{ox} = \frac{75}{4} = 18.75$ m/s

Along y-axis

$y = v_{oy}t - \frac{1}{2}gt^2$

$10 = 4 \times v_{oy} - \frac{1}{2} \times 9.8 \times 16$

$10 = 4v_{oy} - 78.4$

$v_{oy} = \frac{88.4}{4} = 22.1$ m/s

$v_0 = \sqrt{v_{ox}^2 + v_{oy}^2} = \sqrt{(18.75)^2 + (22.1)^2} = 28.99$ m/s

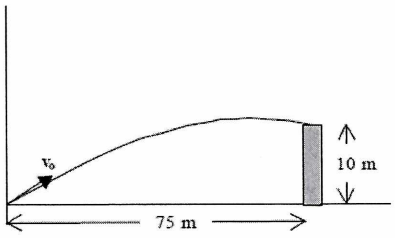
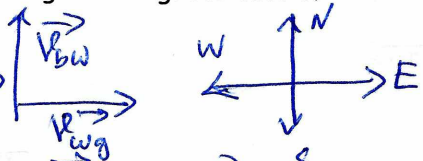


Figure 4

Q#2 A boat is sailing due North at a speed of 4.0 m/s with respect to the water of a river. If the water is moving due East at a speed of 3.0 m/s relative to the ground, what is the velocity of the boat relative to the ground? (A1 5.0 m/s making an angle 37 degrees east of north)

boat velocity relative to water $= \vec{v}_{bw} = 4\vec{j}$

water velocity relative to ground $= \vec{v}_{wg} = 3\vec{i}$



Boat velocity relative to ground $= \vec{v}_{bg} = \vec{v}_{bw} + \vec{v}_{wg} = 4\vec{j} + 3\vec{i}$

$|v_{bg}| = \sqrt{4^2 + 3^2} = 5$ m/s, angle $\theta = \tan^{-1}(4/3) = 53^0$

Q#3: A particle moves horizontally in uniform circular motion in a horizontal *xy* plane. At one instant it moves through the point P at coordinates (4 m, 4 m) with a velocity of- 6*i* m/s and an acceleration of 12$\hat{j}$ m/s2 where and are unit vectors along *x* and *y* axes, respectively (**Figure 3**). Find the *x* and *y* coordinates of the center of the circular path. (A) (4 m, 7 m))

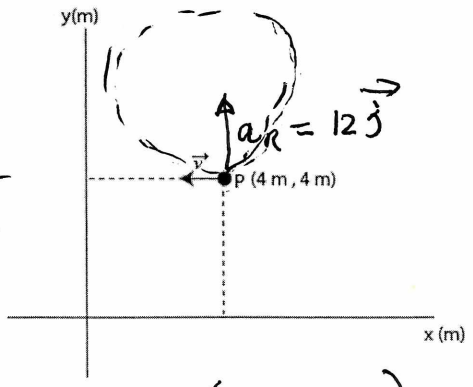
$a_R = 12\vec{j}$ m/s^2

$v = -6i$ m/s

$a_R = \frac{v^2}{R}$

$R = \frac{v^2}{a_R} = \frac{(6)^2}{12}$

$R = 3.0$ m



Coordinates of Center $= (4, 4+R) = (4, 4+3)$

" $= (4, 7)$ m.

Quiz #2 Ch.#4 T121 Phys101.37-39-v4

Student ID:..... Student Name:..... Section # .....

Q1 A stone is thrown horizontally from the top of a building, of height 75 m, with an initial speed of 15 m/s. Find the speed of the stone 2.0 s after it is thrown. (A1 25 m/s)

After $t=2s$, $v_x = v_{ox} = 15\ m/s$

After $t=2s$, $v_y = v_{oy} - gt = 0 - 9.8\times 2 = -19.6\ m/s$

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{15^2 + (19.6)^2} = 24.7\ m/s$$

Q2: A wide river has a uniform flow speed of 3.0 m/s toward the east. A boat with a speed of 8.0 m/s relative to the water leaves point (A) and heads in such a way that it crosses to a point (B) (see Fig.2). In what direction relative to east must the boat be pointed? (A1 112 degrees)

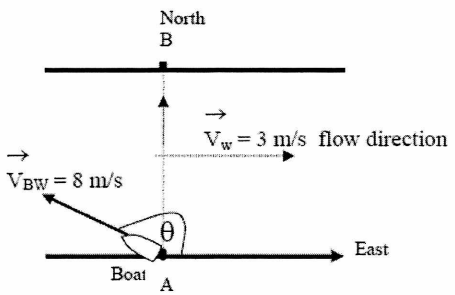
Condition: resultant of the two velocities should have Zero Value of X-Component. The

$$|v_{bw}\cos\theta| = |v_w| \quad ; \vec{v}_w = 3\hat{i}$$

$$\theta = \cos^{-1}\left(\frac{v_w}{-v_{bw}}\right)$$

$$\theta = \cos^{-1}\left(\frac{3}{-8}\right) = 112^0$$

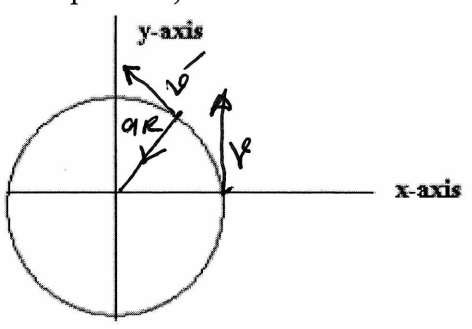
FIGURE-2



Q3 Fig. 2 shows a circular path taken by a particle. If the instantaneous velocity of the particle is **v** = - (4.0 m/s) **i** + (4.0 m/s) **j**, through which quadrant is the particle moving at that instant if it is traveling counterclockwise? ((A) First quadrant)

$\vec{v} = -v_x\hat{i} + v_y\hat{j}$

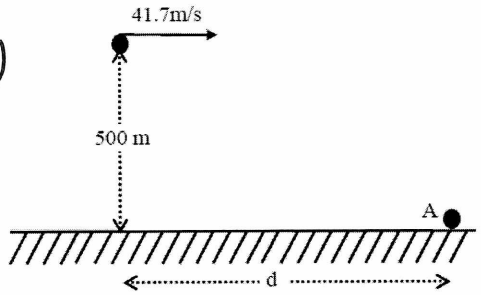
Sign of $\hat{i}$ & $\hat{j}$ agree in the first quadrant only



Quiz #2 Ch.#4 T121 Phys101.37-39-v5

Student ID:..... **Student Name:**..... **Section #** .....

Q1 The airplane shown in Fig. 2 is in level flight at an altitude of 500 m and a speed of 41.7 m/s. At what distance d should it release a bomb to hit the target at point A? (A1 421 m)



Since $t_x = t_y$ The

along y-axis $y = v_{oy}t - \frac{1}{2}gt_y^2$ ($v_{oy}=0$)

$-500 = -\frac{1}{2}\times 9.8 \times t^2$

$t_y = \sqrt{\frac{1000}{9.8}} = 10.1$ Sec

$d = v_{ox} \times t_y$

$d = 41.7 \times 10.1 = 421.2$ m

Q2: The pilot of an airplane flies due north relative to the ground with a speed of 80 km/h. A wind is blowing towards the east with a speed of 40 km/h. What is the speed of the airplane relative to the wind? (A1 89 km/h)

North

East

Airplane Velocity relative to ground $\vec{V}_{PG} = 80\vec{j}$

Wind Velocity relative to ground $\vec{V}_{AG} = 40\vec{i}$

Plane Velocity relative to wind $\vec{V}_{PA} = \vec{V}_{PG} + \vec{V}_{GA} = \vec{V}_{PG} - \vec{V}_{AG}$

$\vec{V}_{PA} = 80\vec{j} - 40\vec{i}$

$|V_{PA}| = \sqrt{80^2 + 40^2} = 89.4$ m/s

Q3 A toy racing car moves with constant speed around the circle as shown in Figure 4. When it is at point A its coordinates are x = 0, y = 3.0 m and its velocity is 6.0 m/s i. When it is at point B its velocity and acceleration are: (A) , +(6.0m/s) j and + (12m/s) i respectively

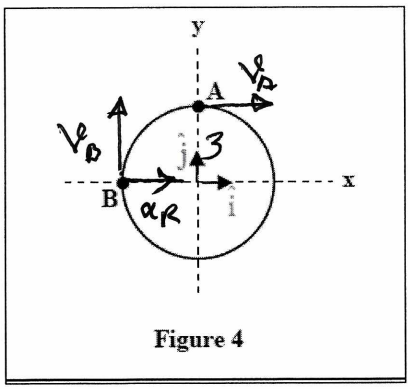


Figure 4

$\vec{V}_B = |V|\vec{j} = 6\vec{j}$

$R = 3.0$ m

$|a|_R = \frac{v^2}{R} = \frac{(6)^2}{3} = 12$

$\vec{a_R} = 12\vec{i}$

Quiz #2 Ch.#4 T121 Phys101.37-39-v6

Student ID:..... **Student Name:**..... **Section #** .....

Q1 A ball is thrown horizontally from the top of a building 100 m high. The ball strikes the ground at a point 65 m horizontally away from the base of the building (Fig 3). What is the speed of the ball just before it strikes the ground? (A1 47 m/s)

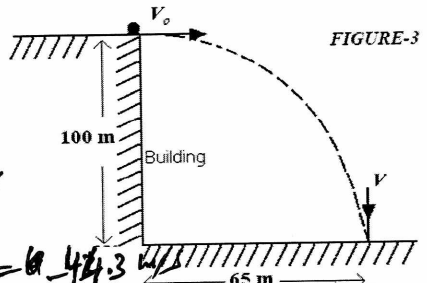


FIGURE-3

$t_x = t_y$, $y = v_{oy} - \frac{1}{2}gt^2$ ($v_{oy}=0$)

along y-axis, $-100 = -\frac{1}{2}\times 9.8 \times t_y^2$

$t_y = \sqrt{\frac{200}{9.8}} = 4.52$ sec

$v_x = v_{ox} = \frac{x}{t_y} = \frac{65}{4.52} = 14.39$ m/s

$v_y = v_{oy} - gt_y = -gt_y = -9.8\times 4.52 = -44.3$ m/s

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(14.39)^2 + (44.3)^2} = 46.6$ m/s

Q2: Rain is falling vertically at constant speed of 6.0 m/s. At what angle from the vertical do the rain appear to be falling as viewed by the driver of a car traveling on a straight, level road with a speed of 8.0 m/s? (A1 53 degrees)

rain speed relative to ground $\vec{v}_{rg} = -6\hat{j}$

Car speed relative to ground $\vec{v}_{cg} = 8\hat{i}$

Rain velocity relative to Car $\vec{v}_{rc} = \vec{v}_{rg} + \vec{v}_{gc} = \vec{v}_{rg} - \vec{v}_{cg}$

$\vec{v}_{rc} = -6\hat{j} - 8\hat{i}$

$\theta = \tan^{-1}\left(\frac{6}{8}\right) = 37^0$ or 53 relative to Vertical

Q3 What is the magnitude of the acceleration of an aircraft, which enters a horizontal circular turn of radius *R* with velocity $v_i = 200\,\boldsymbol{i}$ m/s and 15.0 s later leaves the turn with a velocity $v_f = -200\,\boldsymbol{j}$ m/s ? (see **Figure 2**) (A) 20.9 m/s2)

$a_R = \frac{v^2}{R}$

but $T = \frac{2\pi R}{v}$ or $T = 15\times 4 = 60$ s.

$R = \frac{vT}{2\pi} = \frac{200\times 60}{2\pi}$

$= 1910$ m

$a_R = \frac{v^2}{R} = \frac{200\times 200}{1910}$

$a_R = 20.9$ m/s^2