Physics--Chapter 3: Two-Dimensional Motion and Vectors

Practice Problems

Practice 3A Finding Resultant Magnitude and Direction
1. While following the directions on a treasure map, a pirate walks 45.0 m north, then turns and walks 7.5 m east. What single straight-line displacement could the pirate have taken to reach the treasure?

2. Emily passes a soccer ball 6.0 m directly across the field to Kara, who then kicks the ball 14.5 m directly down the field to Luisa. What is the ball’s total displacement as it travels between Emily and Luisa?

3. A hummingbird flies 1.2 m along a straight path at a height of 3.4 m above the ground. Upon spotting a flower below, the hummingbird drops directly downward 1.4 m to hover in front of the flower. What is the hummingbird’s total displacement?

Practice 3B Resolving Vectors
1. How fast must a truck travel to stay beneath an airplane that is moving 105 km/h at an angle of 25° to the ground?

2. What is the magnitude of the vertical component of the velocity of the plane in #1?

3. Find the horizontal and vertical components of the 125 m displacement of a superhero who flies down from the top of a tall building at an angle of 25° below the horizontal.

4. A child rides a toboggan down a hill that descends at an angle of 30.5° to the horizontal. If the hill is 23.0 m long, what are the horizontal and vertical components of the child’s displacement?
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5. A truck drives up a hill with a 15° incline. If the truck has a constant speed of 22 m/s, what are the horizontal and vertical components of the truck’s velocity?

6. A skier squats low and races down an 18° ski slope. During a 5 s interval, the skier accelerates at 2.5 m/s². What are the horizontal (perpendicular to the direction of free-fall acceleration) and vertical components of the skier’s acceleration during this time interval?

7. What are the horizontal and vertical components of a cat’s displacement when it is climbing 5 m directly up a tree?

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Practice 3C Adding Vectors Algebraically

1. A football player runs directly down the field for 35 m before turning to the right at an angle of 25° from his original direction and running an additional 15 m before getting tackled. What is the magnitude and direction of the runner’s total displacement?
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2. A plane travels 25 km at an angle of 35° to the ground, then changes direction and travels 515 km at an angle of 22° to the ground. What is magnitude and direction of the plane’s total displacement?

3. During a rodeo, a clown runs 8.0 m north, turns 35° east of north, and runs 3.5 m. Then, after waiting for the bull to come near, the clown turns due east and runs 5.0 m to exit the arena. What is the clown’s total displacement?
Practice 3D Projectiles Launched Horizontally
1. A pelican flying along a horizontal path drops a fish from a height of 5.4 m while traveling 5.0 m/s. How far does the fish travel horizontally before it hits the water?

2. Give both the horizontal and vertical components of the velocity of the fish from #1 before the fish enters the water.

3. A cat chases a mouse across a 1.0 m high table. The mouse steps out of the way, and the cat slides off the table at a speed of 5.0 m/s. Where does the cat strike the floor?

Practice 3E Projectiles Launched at an Angle
1. In a scene in an action movie, a stuntman jumps from the top of one building to the top of another building 4.0 m away. After a running start, he leaps at an angle of 15° with respect to the flat roof while traveling at speed of 5.0 m/s. Will he make it to the other roof, which is 2.5 m shorter than the building he jumps from?
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2. A golfer can hit a golf ball a horizontal distance of over 300 m on a good drive. What maximum height would a 301.5 m drive reach if it were launched at an angle of 25.0° to the ground?

3. Salmon often jump waterfalls to reach their breeding grounds. Starting 2.00 m from a waterfall 0.55 m in height, at what minimum speed must a salmon jumping at an angle of 32.0° leave the water to continue upstream?
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4. A quarterback throws the football to a receiver who is 31.5 m down the field. If the football is thrown at an initial angle of 40.0° to the ground, at what initial speed must the quarterback throw the ball? What is the ball’s highest point during its flight?

Practice 3F Relative Velocity

1. A passenger at the rear of a train traveling at 15 m/s relative to Earth throws a baseball with a speed of 15 m/s in the direction opposite the motion of the train. What is the velocity of the baseball relative to Earth as it leaves the thrower’s hand?

2. A spy runs from the front to the back of an aircraft carrier at a speed of 3.5 m/s. If the aircraft carrier is moving forward at 18.0 m/s, how fast does the spy appear to be running when viewed by an observer on a nearby stationary submarine?

3. A ferry is crossing a river. If the ferry is headed due north with a speed of 2.5 m/s relative to the water and the river’s velocity is 3.0 m/s to the east, what will the boat’s velocity be relative to Earth?

4. A pet-store supply truck moves at 25.0 m/s north along a highway. Inside, a dog moves at 1.75 m/s at an angle of 35.0° east of north. What is the velocity of the dog relative to the road?