

Unit 2 Practice Problems: 2-D Velocity and Acceleration

I. Vectors and Motion

- *After walking 11 km due north (90°) from camp, a hiker then walks 21 km due east (0°).
 - What total *distance* was walked by the hiker? (**32 Km**)
 - Determine the total *displacement* from the starting point. (**23.71 Km, 27.6⁰**)
- While flying due east at 120 km/h, an airplane is also carried northward at 45 km/h by the wind blowing due north. What is the plane's resultant velocity? (**128.16 Km/h, 20.56⁰**)
- *An airplane flies toward 149° at 525 km/h. What is the component of the plane's velocity
 - toward 90° ? (**270.39 Km/h**)
 - toward 180° ? (**450.01 Km/h**)
- *A motorboat heads straight across a river at 16 m/s. The river flows downstream at 9.0 m/s.
 - What is the resultant velocity (speed and direction *as taken from the shore*) of the boat? (**18.36 m/s, 60.64⁰**)
 - If the river is 136 m wide, how long does it take the motorboat to reach the other side? (**8.5 s**)
 - How far downstream is the boat when it reaches the other side of the river? (**76.5 m**)
- A motorboat travels at 8.5 m/s. It heads straight across a river 110 m wide.
 - If the water flows downstream at a rate of 3.8 m/s, what is the boat's resultant velocity, relative to the shore? (**9.31 m/s, 65.91⁰**)
 - How long does it take the boat to reach the opposite shore? (**12.94 s**)
- A boat heads directly across a river 41 m wide at 3.8 m/s. The current is flowing downstream at 2.2 m/s.
 - What is the resultant velocity, relative to the shore, of the boat? (**4.39 m/s, 59.93⁰**)
 - How much time does it take the boat to cross the river? (**10.79 s**)
 - How far downstream is the boat when it reaches the other side? (**23.74 m**)
- Sue rows a boat directly across a river at 3.2 m/s. The river flows at 12 m/s and is 200m wide.
 - What velocity, relative to the shore, does Sue's boat go? (**12. 42 m/s, 14.93⁰**)
 - How long does it take Sue to cross the river? (**62.5 s**)
 - How far downstream is Sue's landing point? (**750 m**)
 - How long would it take Sue to cross the river if there were no current? (**the same amount of time as the current is perpendicular to the boat's velocity and, therefore, will not affect the boat's velocity directed directly across the river**)

II. Projectile Motion

- *A stone is thrown horizontally at a speed of + 5.0 m/s off the top of a cliff 78.4m high.
 - How long does it take the stone to reach the bottom of the cliff? (**4 s**)
 - How far from the base of the cliff does the stone strike the ground? (**20 m**)
 - What are the horizontal and vertical components of the velocity of the stone just before it hits the ground? (**$v_{yf} = -39.2 \text{ m/s}$, $v_x = 5 \text{ m/s}$ as there is no acceleration acting on the projectile in the horizontal dxn**)
- An auto, moving too fast on a horizontal stretch of mountain road, slides off the road, falling into deep snow 43.9 m below the road and 87.7 m beyond the edge of the road.
 - How long did the auto take to fall? (**2.99 s**)
 - How fast was it going when it left the road in m/s and km/h? (**horizontal 29.30 m/s and 105.48 Km/h**)
 - What was its acceleration 10 m below the edge of the road? (**still 9.8 m/s/s, down**)
- A steel ball rolls with constant velocity across a tabletop 0.950 m high. It rolls off and hits the ground 0.352m horizontally from the edge of the table. How fast was the ball rolling on the table? (**0.8 m/s**)
- A rude tourist throws a peach pit 7m/s horizontally out of the cage of an elevator.
 - If the elevator isn't moving, how long will it take the pit to reach the ground, 17m below? (**1.86 m**)
 - How far horizontally will the pit land? (**13.04 m**)
 - Repeat a and c if the elevator was moving *up* with a velocity of 2m/s. (**2.08 s, 14.56 m**)
- *A player kicks a football from ground level with a velocity of 27m/s at an angle of 30° above the horizontal. Find
 - The total time the ball is in the air. (**2.76 s**)
 - The distance the ball travels before it hits the ground. (**64.41 m**)
 - Its maximum height. (**9.33 m**)
- Repeat the previous problem for the same player now kicking the ball with the same speed, but at 60° to the horizontal. (**4.77 s, 64.41 m, 27.88m**)
- Repeat the above problem (at the 60 degree angle) for someone on the moon where the acceleration due to gravity is 1.62m/s/s, down. (**28.86 s, 389.67 m, 168.71 m**)
- In baseball, the pitcher's mound is raised to compensate for the fact that the ball falls downward as it travels from the pitcher to the batter. If baseball were played on the moon, would the pitcher's mound have to be higher than, lower than, or the same height as the pitcher's mound on Earth? (**lower...the ball wouldn't fall as fast as it would on Earth**)

16. *A projectile is shot from the edge of a cliff 140 m above the ground level with an initial speed of 100 m/s at an angle of 37.0° with the horizontal
- Determine the time taken by the projectile to hit the ground. (**14.28 s**)
 - Determine the range of the projectile as measured from the base of the cliff. (**1.14 E3 m**)
 - At the instant just before the projectile hits the ground, find the total velocity it hits the ground with (**112.87 m/s, 44.96°**)

Challenging HW problems

17. In a snow skiing long-jump competition, the skiers ski down a ramp that tilts up at the end with a 63-degree angle to the horizontal. With the launch angle, a skier attains a height of 13m above the edge of the ramp. What is the skier's launch speed? (**17.92 m/s**)
18. A rocket is fired at a speed of 75 m/s from ground level at an angle of 60 degrees to the horizontal. The rocket is fired toward a 100m tall wall, which is located 270 m away. By how much does the rocket clear the wall? (**113.62m above the wall**)
19. A diver springs upward from a diving board that is 3m above the surface of the water. At the instant she contacts the water her speed is 8.90 m/s and her body makes an angle of 75.0° to the surface of the water.
- Determine her initial velocity (speed and dxn) that she left the board with. (**4.52 m/s, 59.41°**)
 - How much time did she spend in the air? (**1.27 s**)
20. *When a cannon is aimed at an angle of 36° above the horizontal, a cannon ball lands 140 m down range. What was the muzzle velocity of the cannon? (**37.98 m/s**)