1. Make a well-labeled sketch and calculate the *x* and *y* components of each of the following vectors:

   A = 10.0 m, 30.0° **B** = 205 km, 305.0°
   C = 36.0 m/s, 135.0° **D** = 4.44 m/s^2, 45.0°
   E = 77 m, 195° **F** = 80.0 mph, 180.0°

2. Make a well-labeled sketch and calculate the magnitude and direction for each vector, given its components:

   $G_x = 500$ m, $G_y = 100$ m
   $H_x = -92$ km, $H_y = 23$ km
   $I_x = 14.0$ m/s, $I_y = -8.00$ m/s
   $J_x = -30.0$ m, $J_y = -30.0$ m
   $K_x = 4.00$ m, $K_y = 2.00$ m
   $L_x = 0.00$, $L_y = 2.0$ m/s^2

3. An airplane loses power at an elevation of 200 m and assumes an optimal glide path with velocity 45.0 m/s, 355.0°. Find its descent rate. How much time before it reaches zero elevation? What horizontal distance can it travel before reaching zero elevation?

4. Starting from an initial height of 1200 m above the ground, a parachutist descends at a rate of 5.00 m/s while a steady wind blows him 2.50 m/s westward. Find his velocity. Find his total displacement from the initial point to the point of impact.

5. A policeman's radar gun indicates the motorist's speed at 65.0 mph. If the radar beam is pointing at 0.0° and the car is traveling at 20.0°, what is the motorist's actual speed? Would the motorist want to bring up this discrepancy in court?

6. A turtle's initial position is 5.00 m, 0.0° from the oak tree; 60.0 minutes later the turtle is 3.00 m, 90.0° from the oak tree. Find the turtle's average velocity.

7. An airplane initially 50.0 km, 180.0° from Knoxville, flies with velocity 200.0 km/h, 270.0° for 45.0 minutes. Where is it then?

8. Determine each vector sum or difference by calculation. Include a well-labeled sketch.

   (10.0 km, 45.0°) + (30.0 km, 330.0°) = ?
   (4.00 m, 200.0°) + (3.00 m, 130.0°) = ?
   (25 m/s, 180.0°) – (20 m/s, 315°) = ?

9. A car with initial velocity 25.0 m/s, 30.0° accelerates 0.900 m/s^2, 290.0°. Find its velocity 10.0 seconds later if it continues this acceleration.

10. A UT student is initially in a position of 1.05 km, 249.0° from the Sunsphere. She then goes on a journey of 1.73 km, 170.6°. What is her final position relative to the Sunsphere?

11. An airplane with airspeed 275 km/h and heading 140.0° encounters a wind of 35.0 km/h, 270.0°. Determine the groundspeed and course of this airplane.

12. A submarine heads North with speed through water 15 mph as it moves in current 5.0 mph, east. Find its course and speed over ground.

13. A kid wants to cross a river to a point on the opposite side directly across. The river is 20.0 m wide and has velocity 1.2 m/s, west. How fast does the kid have to swim to reach the opposite bank in 25 s? In what direction should he be headed?

14. A helicopter with velocity 100 km/h, 0.0° relative to the air flies through a wind of 20.0 km/h, 225.0°.
(a) Determine its velocity relative to the earth.
(b) Determine how far south the helicopter moves over the earth in 1.00 minute.

15. A certain boat has a constant speed through the water of 5.0 m/s when it is at full throttle. The boat moves in a river with current 2.0 m/s, 270°. (a) Determine the velocity of the boat relative to the earth if it is headed toward 90°. (b and c) Repeat for headings of 270° and 0°. (d) Determine what heading of the boat would be required to maintain a course of 180° in this current – i.e. which way must the boat point to "go straight across" the river?

16. A pilot wishes to maintain a groundspeed of 250 km/h and a course of due North. If there is a wind of 30.0 km/h, 0.0°, what must be her airspeed and heading?

17. An airplane with airspeed 300 km/h encounters a cross wind of 50.0 km/h blowing toward 90.0°. In order to maintain a course of 0.0°, what must be the heading? What is the resulting groundspeed?

18. Mr. M throws a rock horizontally from atop a 30.0 m cliff with speed 25.0 m/s. (a) Find the time in the air. (b) Find the range. (c) Find the impact speed.

19. A "classroom cannon" is fired horizontally from atop a table and the point of impact is noted on the floor. Determine the muzzle velocity and impact velocity based on measurements of how far the ball falls and how far it travels forward through the room before hitting the floor.

20. An arrow is shot from ground level with initial velocity 40.0 m/s, 60.0°. The arrow flies through the air over a level field and then hits the ground. (a) Find the range. (b) Find the maximum height. (c) Find the impact velocity. (d) Find the minimum speed of the arrow.

21. Using the result from #17 for the muzzle velocity, predict the range and maximum height for a launch angle of _____.

22. The same "classroom cannon" is fired toward the wall from a distance of _____ with a launch angle of _____. Determine the point on the wall where the ball will hit. Determine the impact velocity.

23. A kid kicks a hackey sack off the floor with velocity 8.25 m/s, 76.0°. The sack bounces off the ceiling, which is 3.00 m above the floor. Find the impact speed with the ceiling.