

## Chapter 6 Project Adding Vectors Graphically

### Program

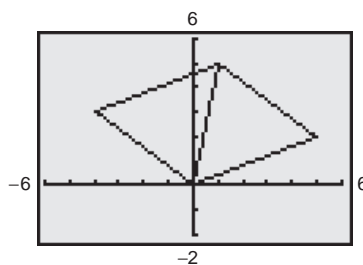
- Input  $a$
- Input  $b$
- Input  $c$
- Input  $d$
- Draw a line from  $(0, 0)$  to  $(a, b)$ .
- Draw a line from  $(0, 0)$  to  $(c, d)$ .
- Add  $a + c$  and store in  $e$ .
- Add  $b + d$  and store in  $f$ .
- Draw a line from  $(0, 0)$  to  $(e, f)$ .
- Draw a line from  $(a, b)$  to  $(e, f)$ .
- Draw a line from  $(c, d)$  to  $(e, f)$ .
- Pause to view graph.
- End program

The psuedo-code at the left can be translated into a program for a graphing utility. (The program for several models of graphing calculators can be found at our website [college.hmco.com](http://college.hmco.com).) The program sketches two vectors

$$\mathbf{u} = a\mathbf{i} + b\mathbf{j} \quad \text{and} \quad \mathbf{v} = c\mathbf{i} + d\mathbf{j}$$

in standard position. Then, using the parallelogram law for vector addition, the program also sketches the vector sum  $\mathbf{u} + \mathbf{v}$ . *Before* running the program, you should set values that produce an appropriate viewing window.

- (a) Use the program to sketch the sum of the vectors  $\mathbf{u} = 5\mathbf{i} + 2\mathbf{j}$  and  $\mathbf{v} = -4\mathbf{i} + 3\mathbf{j}$ . Set your viewing window as indicated in the figure below. Identify the vectors  $\mathbf{u}$ ,  $\mathbf{v}$ , and  $\mathbf{u} + \mathbf{v}$  in the graph.



- (b) An airplane has a bearing of  $300^\circ$  W at a speed of 400 miles per hour. The airplane encounters wind of velocity 75 miles per hour in the direction N  $40^\circ$  E. Use the program to find the resultant speed and direction of the airplane.

### Chapter Project Investigations



In Questions 1–4, use the program above to graph the sum of the vectors. Use the result to estimate graphically the components of the sum. Then check your result analytically. (Use  $-9 \leq x \leq 9$  and  $-6 \leq y \leq 6$ .)

1.  $\mathbf{u} = 3\mathbf{i} + 4\mathbf{j}$ ,  $\mathbf{v} = -5\mathbf{i} + \mathbf{j}$
2.  $\mathbf{u} = 5\mathbf{i} - 4\mathbf{j}$ ,  $\mathbf{v} = 3\mathbf{i} + 2\mathbf{j}$
3.  $\mathbf{u} = -4\mathbf{i} + 4\mathbf{j}$ ,  $\mathbf{v} = -2\mathbf{i} - 6\mathbf{j}$
4.  $\mathbf{u} = 7\mathbf{i} + 3\mathbf{j}$ ,  $\mathbf{v} = -2\mathbf{i} - 6\mathbf{j}$
5. After encountering the wind, is the airplane in part (b) above traveling at a higher speed or a lower speed? Explain.
6. Consider the airplane described in part (b). What wind velocity, in the direction of N  $40^\circ$  E, will produce a resultant direction of  $310^\circ$ ? Explain how to use the program above to obtain the answer *experimentally*. Then explain how to obtain the answer analytically.
7. Consider the airplane described in part (b). What wind direction, at a speed of 75 miles per hour, will produce a resultant direction of  $310^\circ$ ? Explain how to use the program above to obtain the answer *experimentally*. Then explain how to obtain the answer analytically.