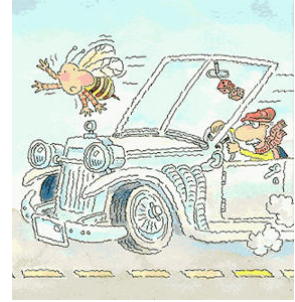
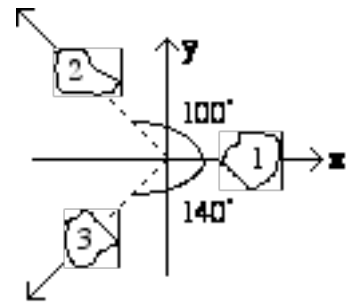


1. A bug flying northward at  $8.00\text{m/s}$  collides with the windshield of a car traveling southward at  $20.0\text{m/s}$ . Answer the following questions. For full credit, you must explain your thinking. Be sure to cite any relevant principles of physics. Which object, the bug or the car (a) feels the greater force during the collision? (b) has the greater acceleration during the collision? (c) has the greater impulse on it during the collision? (d) has the greater change in momentum during the collision? (e) has the greater momentum after the collision?



2. A railroad car traveling east at a speed of  $4.00\text{m/s}$  collides and couples with three identical cars already coupled together traveling in the opposite direction at  $2.00\text{m/s}$ . Find the velocity of the four coupled cars just after the collision.

3. A pumpkin collides with the ground and breaks into three pieces of equal mass. The x-y plane shown at the right illustrates only the horizontal motion since momentum will only be conserved in this plane. Why is momentum not conserved in the vertical direction? The first piece heads off with a speed of  $20.0\text{m/s}$ . The second moves away at a  $100^\circ$  angle with respect to the first and the third heads off at  $140^\circ$  as shown in the sketch. Find the speed of the second and third pieces, respectively.



4. Three equally massive and equally strong astronauts are outside their ship in outer space. Two of them get the bright idea to play a game of catch by throwing the third one back and forth. Suppose the game begins with the first astronaut throwing the third astronaut toward the second astronaut at a speed  $v_0$ . Describe the rest of the game. This means that you must find the velocity of each astronaut after each catch and after each throw. Sketches of the game at each stage might be the best way to explain your answer. Be sure to explain your thinking and state the principles of physics you use.

