52. We orient our $+x$ axis along the initial direction of motion, and specify angles in the "standard" way – so $\theta = +60°$ for one ball (1) which is assumed to go into the first quadrant with speed $v_1' = 1.1$ m/s, and $\phi < 0$ for the other ball (2) which presumably goes into the fourth quadrant. The mass of each ball is m, and the initial speed of one of the balls is $v_0 = 2.2$ m/s. We apply the conservation of linear momentum to the x and y axes respectively.

$$\begin{aligned} mv_0 &= mv_1' \cos\theta + mv_2' \cos\phi \\ 0 &= mv_1' \sin\theta + mv_2' \sin\phi \end{aligned}$$

The mass m cancels out of these equations, and we are left with two unknowns and two equations, which is sufficient to solve.

(a) With SI units understood, the y-momentum equation can be rewritten as

$$v_2' \sin\phi = -v_1' \sin 60° = -0.95$$

and the x-momentum equation yields

$$v_2' \cos\phi = v_0 - v_1' \cos 60° = 1.65$$

Dividing these two equations, we find $\tan\phi = -0.577$ which yields $\phi = -30°$. If we choose to measure this as a positive-valued angle (as the textbook does in §10-6), then this becomes 30°. We plug $\phi = -30°$ into either equation and find $v_2' \approx 1.9$ m/s.

(b) One can check to see if this an elastic collision by computing

$$\frac{2K_i}{m} = v_0^2 \quad \text{and} \quad \frac{2K_f}{m} = {v_1'}^2 + {v_2'}^2$$

and seeing if they are equal (they are), but one must be careful not to use rounded-off values. Thus, it is useful to note that the answer in part (a) can be expressed "exactly" as $v_2' = \frac{1}{2}v_0\sqrt{3}$ (and of course $v_1' = \frac{1}{2}v_0$ "exactly" – which makes it clear that these two kinetic energy expressions are indeed equal).