4 A ball X moves along a horizontal frictionless surface and collides with another ball Y, as illustrated in Fig. 4.1.

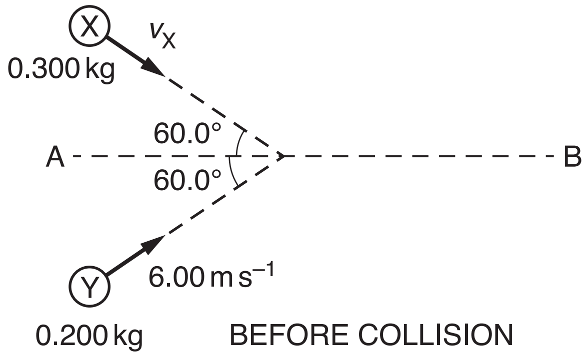


Fig. 4.1 (not to scale)

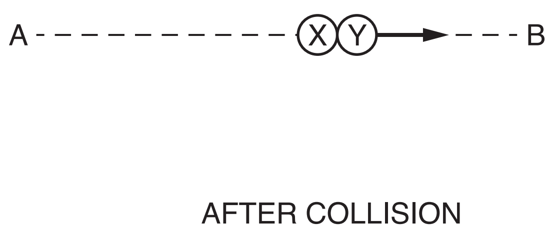


Fig. 4.2 (not to scale)

Ball X has mass 0.300 kg and initial velocity v_X at an angle of 60.0° to line AB.
Ball Y has mass 0.200 kg and initial velocity 6.00 m s^{-1} at an angle of 60.0° to line AB.
The balls stick together during the collision and then travel along line AB, as illustrated in Fig. 4.2.

(a) **(i)** Calculate, to three significant figures, the component of the initial momentum of ball Y that is perpendicular to line AB.

component of momentum = ... kg m s^{-1} [2]

(ii) By considering the component of the initial momentum of each ball perpendicular to line AB, calculate, to three significant figures, v_X.

v_X = ... m s^{-1} [1]

(iii) Show that the speed of the two balls after the collision is 2.4 m s^{-1}.

[2]

(b) The two balls continue moving together along the horizontal frictionless surface towards a spring, as illustrated in Fig. 4.3.

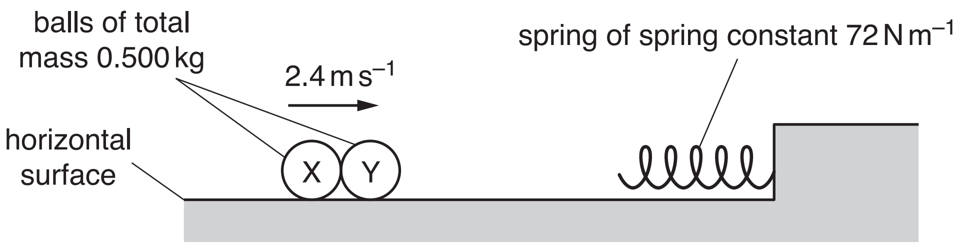


Fig. 4.3

The balls hit the spring and remain stuck together as they decelerate to rest. All the kinetic energy of the balls is converted into elastic potential energy of the spring. The energy E stored in the spring is given by

$$E = \frac{1}{2}kx^2$$

where k is the spring constant of the spring and x is its compression.
The spring obeys Hooke's law and has a spring constant of $72\,\text{N}\,\text{m}^{-1}$.

(i) Determine the maximum compression of the spring caused by the two balls.

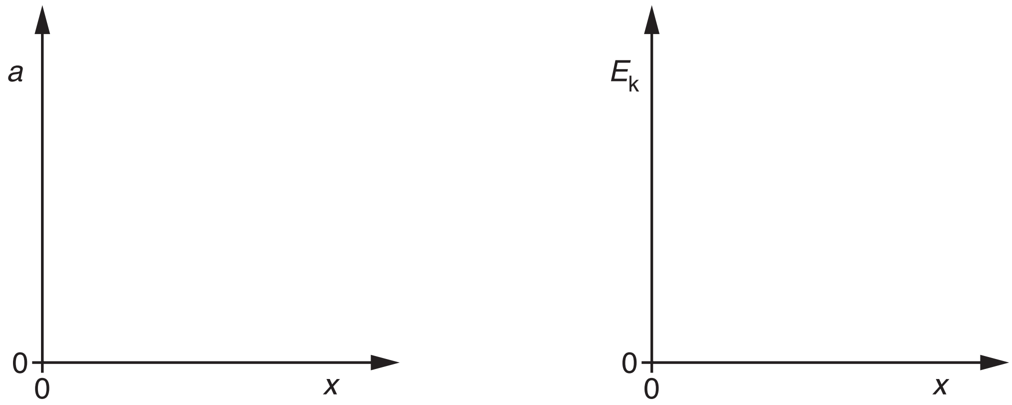
maximum compression = ... m [3]

(ii) On Fig. 4.4, sketch graphs to show the variation with compression x of the spring, from zero to maximum compression, of:

1. the magnitude of the deceleration a of the balls

2. the kinetic energy E_k of the balls.

Numerical values are not required.



[3]

Fig. 4.4

[Total: 11]