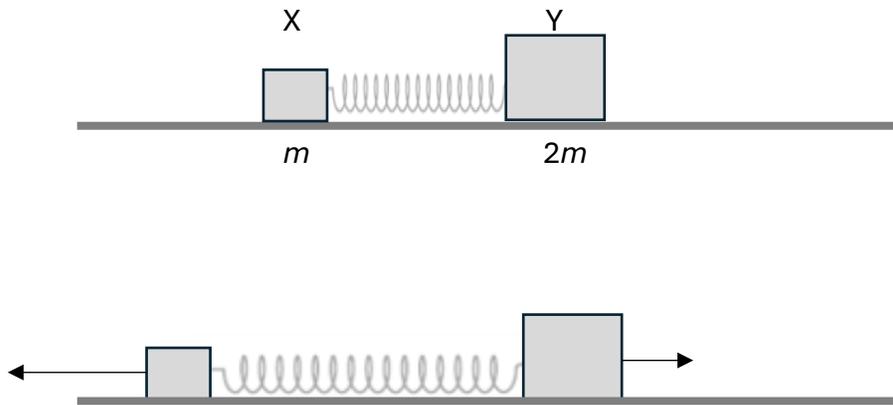# Teacher notes
Topic A

Two blocks X and Y of mass m and $2m$ have a compressed spring between them as shown. The floor is frictionless. The blocks are released and start moving in opposite directions as the spring decompresses. In the lower diagram the spring is unstretched and the blocks are about to lose contact with the spring.

(a) The spring exerts a force F_X on X and F_Y on Y. What is $\dfrac{F_X}{F_Y}$?

(b) Why does X move a greater distance than Y while they are both in contact with the spring?

(c) After the spring loses contact with X has speed v_X and Y has speed v_Y. What is $\dfrac{v_X}{v_Y}$?

(d) What is the ratio of kinetic energies $\dfrac{K_X}{K_Y}$ after the blocks lose contact with the spring?

(e) $K_X = 12\,\text{J}$. What was the elastic energy stored initially in the spring?

(f) What is the work done by F_X on X?

Answers

(a) The forces on X and Y are caused by the tension in the spring and so they are equal, $\dfrac{F_X}{F_Y} = 1$.

(b) The force on X and Y is the same but X has the smaller mass so it has the larger acceleration. Hence, in the same time it travels a longer distance.

(c) Conservation of momentum says $mv_X = 2mv_Y$, hence $\dfrac{v_X}{v_Y} = 2$. Momentum is conserved because there are no external forces on the system of the blocks and the spring.

(d) The blocks have the same magnitude of momentum p and so $\dfrac{K_X}{K_Y} = \dfrac{\frac{p^2}{2m}}{\frac{p^2}{4m}} = 2$.

Alternatively, $\dfrac{K_X}{K_Y} = \dfrac{\frac{1}{2}mv_X^2}{\frac{1}{2}2mv_Y^2} = \dfrac{v_X^2}{2v_Y^2} = \dfrac{4}{2} = 2$.

(e) If $K_X = 12$ J then $K_Y = 6.0$ J. Hence the elastic energy stored in the spring initially was 18 J.

(f) The work done by F_X on X is the change in KE of X i.e. 12 J. This is because F_X is the net force on X and $W_{net} = \Delta E_K$.