

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

8 Momentum

Exercise A, Question 19

Question:

A sledge, of mass 10 kg, is at rest on an icy, horizontal surface. A child, of mass 40 kg, is standing on the sledge.

The child jumps off the sledge. Initially the child travels horizontally at 2 m s^{-1} and the sledge begins to slide in the opposite direction to the child.

(a) Assuming that momentum is conserved, find the speed of the sledge, just after the child has jumped off it.

(b) The coefficient of friction between the sledge and the ice is 0.2.

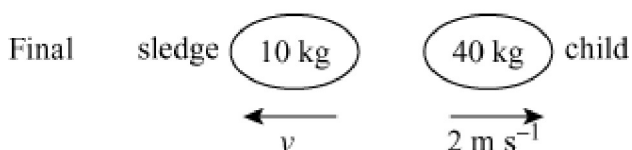
(i) Find the magnitude of the friction force acting on the sledge while it is moving.

(ii) Find the distance that the sledge slides before it comes to rest. [A]

Solution:

(a)

Initial (both at rest)



Using conservation of momentum as child jumps off sledge,

$$0 = 10v - 40 \times 2$$

Speed of sledge is 8 m s^{-1}

For the sledge, $F = \mu R$ where $R = 10g \text{ N}$

$$\begin{aligned} \text{(b) (i) } \therefore F &= 0.2 \times 10g \\ &= 2g \end{aligned}$$

\therefore Frictional force is $2g \text{ N}$ or 19.6 N

Using $F = ma$ for the sledge,

$$\text{(ii) } -19.6 = 10a$$

$$\Rightarrow a = -1.96 \text{ m s}^{-2}$$

For the sliding sledge,

$$\begin{aligned}\text{using } v^2 &= u^2 + 2as, \\ 0 &= 8^2 - 2 \times 1.96 \times s \\ s &= \frac{64}{2 \times 1.96} \\ &= 16.32 \text{ m}\end{aligned}$$

∴ Distance is 16.3 m.

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