Question #59895, Physics / Other | for completion.

Four railroad cars, each of mass 2.50x10^4 kg, are coupled together and coasting along horizontal tracks at speed vi toward the south. A very strong but foolish actor, riding on the second car, uncouples the front car and gives it a big push, increasing its speed to 4 m/s southward. The remaining three cars continue moving south, now at 2 m/s.
a) find the initial speed of the four cars.
b) by how much did the potential energy within the body of the actor change ?

$m = 2{,}5 \cdot 10^4\ kg$

$v_1 = 2\ m/s$

$v_2 = 4\ m/s$

$v_i = ?$

$\Delta E_p = ?$

Solution

a) According to the law of conservation of momentum: $\mathrm{P}_1 = \mathrm{P}_2$ that is,

$4mv_i = 3mv_1 + mv_2$,

where $v_1 -$ speed of the three cars, v_2 - speed of car.

$4mv_i = 6m + 4m = 10m$

$v_i = 2{,}5$ m/s

b) The change of potential energy equal to the change of kinetic energy.

$\Delta E_P = \Delta E_K$

$\Delta E_K = E_{K_1} - E_{K_2} = \frac{4mv_i^2}{2} - \left(\frac{3mv_1^2}{2} + \frac{mv_2^2}{2}\right) = 2mv_i^2 - (6m + 8m) = 12{,}5m - 14m = -1{,}5m = -3{,}75 \cdot 10^4\ J$

The potential energy within the body of the actor decreased by the amount *of* $3{,}75 \cdot 10^4\ J$

Answer the questions: $v_1 = 2{,}5\frac{m}{s},\ \Delta E_p = -3{,}75 \cdot 10^4 J.$