Quiz 09: Chapter 15

Due: Tuesday 21 Feb 23

Examine the solved problem below. There are four errors in the solution below. Your task is to locate and identify those errors, then correct them and calculate the proper result. If the same error occurs more than once, only count it as a single error, even if you have to correct it in more than one instance.

Each correctly identified error is worth 4 points, and the re-calculated results are worth 4 points as well. You must save your work in pdf format and submit via the Quiz 09 Assignment in the Chapter 15 folder of the in the Quizzes folder in the Online Classroom in Blackboard. Please do not use any other file format than pdf.

Block *B* has a mass $m_B = 35$ kg and rests on the surface of the cart having a mass $m_C = 60$ kg. If the spring which is attached to the cart (but not the block) is compressed by $\Delta x = 0.25$ m and the system is released from rest, determine the speed of the block relative to the ground after the spring becomes undeformed. Neglect friction, the mass of the cart's wheels, and the spring mass in the calculation. Take $k = 350 \frac{\text{m}}{\text{m}}$.

A) Conserve energy while the spring decompresses:

$$T_0 + V_0 = T_1 + V_1$$

$$0 + \frac{1}{2}k\Delta x^2 = \frac{1}{2}m_Bv_B^2 + \frac{1}{2}m_Cv_C^2$$

$$\frac{1}{2}\left(350\frac{N}{m}\right)(0.25m)^2 = \frac{1}{2}(35kg)v_B^2 + \frac{1}{2}(60kg)v_C^2$$

$$43.75J = (17.5kg)v_B^2 + (30kg)v_C^2$$

B) Conserve momentum of the system:

 $\sum_{p_{0}} p_{0} = \sum_{p_{1}} p_{1}$ $p_{spr} + p_{Bi} + p_{Ci} = p_{spr} + p_{Bf} + p_{Cf}$ $k\Delta x + 0 + 0 = 0 + m_{B}v_{B} + m_{C}v_{C}$ $(350\frac{N}{m})(0.25m) = (35kg)v_{B} + (60kg)v_{C}$ $87.5N = (35kg)v_{B} + (60kg)v_{C}$

C) Solve the system of equations:

 $\begin{aligned} 87.5 &= 35v_B + 60v_C \\ v_B &= 2.5 - 1.71v_C \\ 43.75 &= 17.5v_B^2 + 30v_C^2 \\ 43.75 &= 17.5(2.5 - 1.71v_C)^2 + 30v_C^2 \\ 43.75 &= 17.5(6.25 - 4.275v_C + 2.94v_C^2) + 30v_C^2 \\ 81.4v_C^2 - 74.8v_C + 65.6 &= 0 \end{aligned}$

D) Use a solver to caclculate the numeric solution:

Using Wolfram α :

 $v_{\rm C} = 0.459459 \pm 0.771229 = 1.231 \text{ or } -0.312$ $v_{B} = 2.5 - 1.71(1.231) = +0.395 \text{ or}$ $v_{B} = 2.5 - 1.71(-0.312) = +3.03$

E) Choose the final answer:

Because the spring decompresses to the right, and we assumed that its initial momentum was positive, then the velocity of the block to the right will be positive and the velocity of the cart will be negative. That makes the second solution the correct one:

$$v_{\rm C} = -0.312 \frac{\rm m}{\rm s}$$
$$v_B = +3.03 \frac{\rm m}{\rm s}$$

