

## Physics 2211K

### Quiz # 6 Solutions

*Three identical train cars*, coupled together, are rolling east ( $+x$  direction) at  $v1$ . A *fourth car* traveling east ( $+x$ ) at  $v2$  catches up with the three and couples to make a four-car train. A moment later, the train cars hit *a fifth car that was at rest* on the tracks, and it couples to make a five-car train traveling at  $vf$ .

- **Analysis:** all masses are the same; also, there are two perfectly inelastic collisions. The first is between the initial three-car group and the fourth car (resulting in a four-car group), and the second is between the four-car group of the 1<sup>st</sup> collision and the fifth car.

*Momentum is conserved in both collisions.*

$$\text{1st collision : } (3m)(v1) + (m)(v2) = (4m)(v')$$

$$\text{2nd collision : } (4m)(v') + 0 = (5m)(vf)$$

*Combining the relations from the two collisions gives :*

$$(3m)(v1) + (m)(v2) = (5m)(vf)$$

*Finally, dividing both sides by  $m$  gives :*

$$3v1 + v2 = 5vf$$

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- If  $v1 = 2.0$  m/s and  $v2 = 4.0$  m/s, what is  $vf$ ?

$$3v1 + v2 = 5vf \Rightarrow vf = \frac{3v1 + v2}{5} = 2.0 \text{ m/s}$$

- If  $v1 = 3.0$  m/s and  $vf = 2.6$  m/s, what is  $v2$ ?

$$3v1 + v2 = 5vf \Rightarrow v2 = 5vf - 3v1 = 4.0 \text{ m/s}$$

- If  $v2 = 4.0$  m/s and  $vf = 3.2$  m/s, what is  $v1$ ?

$$3v1 + v2 = 5vf \Rightarrow v1 = \frac{5vf - v2}{3} = 4.0 \text{ m/s}$$

(So, how does the 4<sup>th</sup> car overtake the 3-car group if they travel at the same speed? A good question unanswered by the statement of the problem!!!!)