Problem 2

In the "rest" frame the velocity of the first car ($m_1 = 2000kg$) is $u_{1x} = 20m/s$, that of the second car ($m_2 = 1500kg$) is $u_{2x} = 0$. So the total momentum before the collision is

$$p_x = m_1 u_{1x} + m_2 u_{2x} = 4 \times 10^4 kg\, m/s$$

which must be conserved and is the same after the collision. The total mass of the wreck (the two cars stuck together) after the collision is $M = m_1 + m_2 = 3500kg$. Thus, the velocity of the wreck after the collision is

$$u_x = \frac{p_x}{M} = \frac{4 \times 10^4 kg\, m/s}{3500kg} \approx 11.43m/s$$

Now let us transform to the "moving" frame with velocity $v = 10m/s$. Applying the Galilean transformation law (1.2) for velocities we get that the velocity of the first car before the collision in this frame is

$$u'_{1x} = u_{1x} - v = 10m/s$$

the velocity of the second car is

$$u'_{2x} = u_{2x} - v = -10m/s$$

and that of the wreck is

$$u'_x = u_x - v \approx 1.43m/s$$

The total momentum before the collision in the "moving" frame is thus

$$p'_{x,initial} = m_1 u'_{1x} + m_2 u'_{2x} = 5000kg\, m/s$$

while after the collision we have

$$p'_{x,final} = M u'_x = 5000kg\, m/s$$

Hence $p'_{x,final} = p'_{x,initial}$ and the momentum is conserved in the "moving" frame. Note that the final result may be slightly off because of the rounding of the numerical results above.