1. A billiard ball (mass = 0.15 kg) is moving at 1.0 $^{m}/\_{s}$. It rebounds from a side cushion with the same speed.
	1. What was the ball's change in momentum? *(Note: Be sure to designate which direction is "positive" and "negative.")*

$$∆p=m∙∆v=m\left(v\_{2}-v\_{1}\right)=\left(0.15 kg\right)(-1.0^{m}/\_{s}-1.0^{m}/\_{s})$$

$$$$

* 1. How is momentum conserved in this collision?

***The momentum is conserved in the system. Since the ball collides with the side cushion, when we consider the cushion we will see momentum is conserved.***

1. A 4.0 kg mass is moving at 3.0 $^{m}/\_{s} $toward the right and a 6.0 kg mass is moving at 2.0 $^{m}/\_{s}$ to the left on a horizontal frictionless table. If the two masses collide and remain together after the collision, what is their final momentum?

$$p\_{before}=p\_{after}=m\_{1}v\_{1}+m\_{2}v\_{2}=\left(4.0 kg\right)\left(3.0 ^{m}/\_{s}\right)+\left(6.0 kg\right)\left(-2.0 ^{m}/\_{s}\right)=0 N∙s$$

$$$$

1. A toy train car with a mass of 200. g and a velocity of 0.80 $^{m}/\_{s}$ collides with a second car that is at rest and has equal mass. The two cars couple together.
	1. Assuming no friction, what is the velocity of the 2 cars after collision?

$$p\_{before}=p\_{after}↝m\_{1}v\_{1}+m\_{2}v\_{2}=\left(m\_{1}+m\_{2}\right) v '$$

$$\left(0.200 kg\right)\left(0.80 ^{m}/\_{s}\right)+\left(0.200 kg\right)\left(0 ^{m}/\_{s}\right)=\left(0.200 kg+0.200 kg\right) v '$$

$$$$

* 1. What is the momentum of the 2-car system before and after the collision?

$$p\_{before}=m\_{1}v\_{1}+m\_{2}v\_{2}=\left(0.200 kg\right)\left(0.80 ^{m}/\_{s}\right)+\left(0.200 kg\right)\left(0 ^{m}/\_{s}\right)=0.16 N∙s$$

$$$$

* 1. The two moving cars above collide with a 3rd car, mass of 150 g (at rest), and couple together. What is the resulting velocity of the 3 cars?

$$p\_{before}=p\_{after}↝\left(m\_{1}+m\_{2}\right)v\_{1+2}+m\_{3}v\_{3}=\left(m\_{1}+m\_{2}+m\_{3}\right) v '$$

$$\left(0.200 kg+0.200 kg\right)(0.40^{m}/\_{s})+\left(0.150 kg\right)\left(0^{m}/\_{s}\right)=\left(0.200 kg+0.200 kg+0.150 kg\right) v '$$

$$$$

* 1. What is the momentum before and after the collision?

$$$$

1. A small child on a sled (total mass 45 kg) is pulled so that the sled goes from rest to 4.5 m/s.
	1. If the force applied is 40. N, what is the total distance covered during the impulse?

$$F\_{NET}=ma ↝a=\frac{F\_{NET}}{m}=\frac{40 N}{45 kg }=0.89^{m}/\_{s^{2}}$$

$$v\_{2}^{2}=v\_{1}^{2}+2ad↝d=\frac{v\_{2}^{2}-v\_{1}^{2}}{2a}=\frac{\left(4.5^{m}/\_{s}\right)^{2}-\left(0^{m}/\_{s}\right)^{2}}{2\left(0.89^{m}/\_{s^{2}}\right)}$$

$$$$

* 1. What is the change in momentum of the child and sled? Is momentum conserved? Explain…

$$I=∆p=m∙∆v=m\left(v\_{2}-v\_{1}\right)=\left(45 kg\right)(4.5^{m}/\_{s}-0^{m}/\_{s})$$

$$$$

***When we only look at the child on the sled, there is a change in momentum. However, momentum is conserved for the whole system.***

1. A 1200 kg railroad car travels alone on a level frictionless track with a constant speed of 18 $^{m}/\_{s}$. A 5750 kg additional load (initially at rest) is dropped onto the car. What will the cars speed be after the additional cargo is added?

$$p\_{before}=p\_{after}↝m\_{1}v\_{1}+m\_{2}v\_{2}=\left(m\_{1}+m\_{2}\right) v '$$

$$\left(1200 kg\right)(18^{m}/\_{s})+\left(5750 kg\right)\left(0^{m}/\_{s}\right)=\left(1200 kg+5750 kg\right) v '$$

$$$$

1. A 9500 kg boxcar traveling at 16 $^{m}/\_{s}$ strikes a second car at rest. The two stick together and move off with a speed of 6.0 $^{m}/\_{s}$. What is the mass of the second car?

$$p\_{before}=p\_{after}↝m\_{1}v\_{1}+m\_{2}v\_{2}=\left(m\_{1}+m\_{2}\right) v '$$

$$\left(9500 kg\right)(16^{m}/\_{s})+\left(0^{kg∙m}/\_{s}\right)=\left(9500 kg+m\_{2}\right) \left(6.0^{m}/\_{s}\right)$$

$$$$