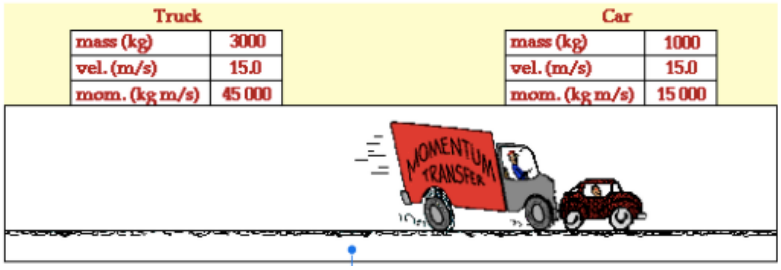
Thnking Proportionally About Collisions

Lesson Notes

The Law of Momentum Conservation:

For any collision or explosion occurring in an isolated system, the total amount of momentum possessed by objects within the system is conserved (i.e., remains unchanged).



Before Collision:
60 000 kg•m/s + 0 kg• m/s

After Collision:
45 000 kg•m/s + 15 000 kg•m/s

The truck loses momentum. The car gains momentum. But the combined momentum ("system total") remains unchanged. It is **conserved**.

Thinking Proportionally

Requirements:

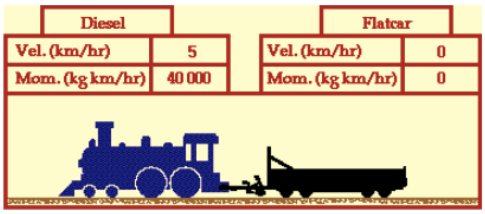
1. Before collision: one object is at rest; the other is moving.
2. After collision: both objects move at the same speed.

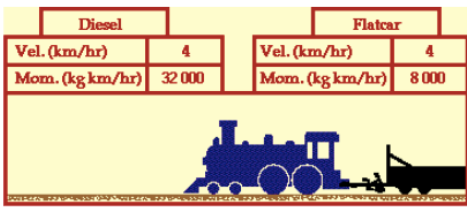
For total system momentum to be conserved ….

- If the amount of mass that is moving increases, then the speed at which it moves must decrease.
- The factor by which the mass increases must be equal to the factor by which the speed decreases.

Flat Car-Diesel Collisions - an Example

Consider the diesel-flatcar collision: m_{diesel} = 8000 kg, $m_{flatcar}$ = 2000 kg





- Before the collision, there is **8000-kg** (the diesel) of mass moving with a velocity of 5 km/hr.
- After the collision, there is **10 000 kg** (diesel + flatcar) moving at the same speed.
- The amount of mass that is moving has increased by a factor of **5/4**.
- To conserve total system momentum, the velocity at which this mass moves will 4/5-ths of the original value. This would be equivalent to 4 km/hr.

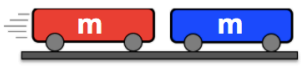
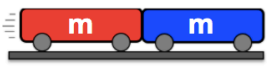
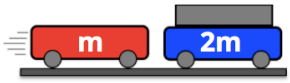
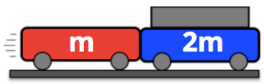
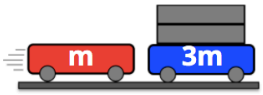
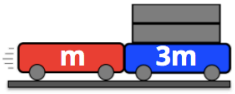
Fish Catch Example

Consider the hit-and-stick collision of a little fish and a big fish.

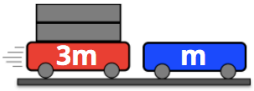
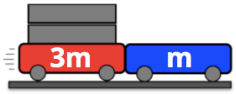
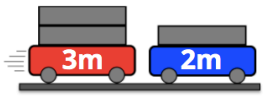
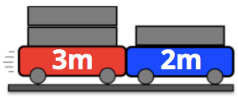
Relative Mass			Before-Coll'n Speed (cm/s)	Factor by Which ...		After Coll'n Speed (cm/s)
Little Fish	Big Fish	Little + Big Fish		Mass ↑	Speed ↓	
m	3•m	4•m	120	x4	÷4	30
m	4•m	5•m	120	x5	÷5	24
m	5•m	6•m	120	x6	÷6	20

Red Cart - Blue Cart Collision

A red cart moving at **60 cm/s** collides with a stationary blue cart. The two carts stick together and move at the same speed after the collision.

Before Collision	After Collision	The amount of mass that is moving ↑ by a factor of ...	... so the speed at which the carts move ↓ by a factor of ...	... so the final speed is ....
		x2	÷2	30 cm/s
		x3	÷3	20 cm/s
		x4	÷4	15 cm/s

... and more ...

		x1.5	÷1.5	40 cm/s
		x1.333	÷1.333	45 cm/s
		x1.666	÷1.666	36 cm/s