Smart Cart Collisions Exploration

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May 18, 2022

1 Collision Observations

The Five Collision Scenarios:

1. **Collision 1:** Both carts equal mass | Bounce of magnets | Cart 2 (Blue) at rest
2. **Collision 2:** Both carts equal mass | Bounce of magnets | Roll towards each other
3. **Collision 3:** $m_2 = 2m_1$ | Bounce of magnets | Cart 2 (Blue) at rest
4. **Collision 4:** $m_2 = 2m_1$ | Bounce of magnets | Roll towards each other
5. **Collision 5:** Both carts equal mass | Stick together after | Cart 2 (Blue) at rest

Table 1: Observed Data for Cart 1 (Red) in all Five Collision Scenarios

Collision Number	**Cart 1 Mass (kg)**	**Cart 1 $\vec{v}_i$ (m/s)**	**Cart 1 $\vec{v}_f$ (m/s)**	**Cart 1 $\vec{p}_i$ (kg · m/s)**	**Cart 1 $\vec{p}_f$ (kg · m/s)**
Collision 1	0.270	0.911	0.000	0.246	0.000
Collision 2	0.270	0.455	-0.396	0.123	-0.107
Collision 3	0.270	0.580	0.000	0.157	0.000
Collision 4	0.270	0.631	-0.520	0.170	-0.140
Collision 5	0.270	0.692	0.341	0.187	0.092

Table 2: Observed Data for Cart 2 (Blue) in all Five Collision Scenarios

Collision Number	**Cart 2 Mass (kg)**	**Cart 2 $\vec{v}_i$ (m/s)**	**Cart 2 $\vec{v}_f$ (m/s)**	**Cart 2 $\vec{p}_i$ (kg · m/s)**	**Cart 2 $\vec{p}_f$ (kg · m/s)**
Collision 1	0.270	0.000	0.885	0.000	0.239
Collision 2	0.270	-0.476	0.386	-0.129	0.104
Collision 3	0.532	0.000	0.321	0.000	0.171
Collision 4	0.532	-0.616	0.000	0.328	0.000
Collision 5	0.270	0.000	0.343	0.000	0.093

Table 3: Total Momentum and Kinetic Energy in all Five Collision Scenarios

Collision Number	**Total $\vec{p}$ Before (kg · m/s)**	**Total $\vec{p}$ After (kg · m/s)**	**Total E_k Before (J)**	**Total E_k After (J)**
Collision 1	0.246	0.239	0.112	0.106
Collision 2	-0.006	-0.003	0.059	0.041
Collision 3	0.157	0.171	0.045	0.027
Collision 4	-0.157	-0.140	0.155	0.037
Collision 5	0.187	0.185	0.065	0.032

2 Explosion Observations

The Two Explosion Scenarios:

1. **Explosion 1:** Two carts of equal mass "explode" away from each other
2. **Explosion 2:** Two carts of unequal mass "explode" away from each other

Table 4: Observed Data for Cart 1 (Red) in Both Explosion Scenarios

Explosion Number	Cart 1 Mass (kg)	Cart 1 $\vec{v}_i$ (m/s)	Cart 1 $\vec{v}_f$ (m/s)	Cart 1 $\vec{p}_i$ (kg · m/s)	Cart 1 $\vec{p}_f$ (kg · m/s)
Explosion 1	0.270	0.000	0.796	0.000	0.215
Explosion 2	0.270	0.000	0.945	0.000	0.255

Table 5: Observed Data for Cart 2 (Blue) in Both Explosion Scenarios

Collision Number	Cart 2 Mass (kg)	Cart 2 $\vec{v}_i$ (m/s)	Cart 2 $\vec{v}_f$ (m/s)	Cart 2 $\vec{p}_i$ (kg · m/s)	Cart 2 $\vec{p}_f$ (kg · m/s)
Explosion 1	0.270	0.000	-0.848	0.000	-0.229
Explosion 2	0.532	0.000	-0.506	0.000	-0.269

Table 6: Total Momentum and Kinetic Energy in Both Explosion Scenarios

Collision Number	Total $\vec{p}$ Before (kg · m/s)	Total $\vec{p}$ After (kg · m/s)	Total E_k Before (J)	Total E_k After (J)
Explosion 1	0.000	-0.014	0.000	0.183
Explosion 2	0.000	-0.014	0.000	0.189

3 Collision Analysis

4 Explosion Analysis