

# Smart Cart Collisions Exploration

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# 1 Collision Observations

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      | 0.498                             | -0.140                           | 0.155                  | 0.037                 |
| Collision 5      | 0.187                             | 0.185                            | 0.065                  | 0.032                 |

## 2 Explosion Observations

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                 |