

Department of Biological, Chemical, and Physical Science
Illinois Institute of Technology
General Physics I: Mechanics (PHYS 123-02)

Momentum

Lab 9

Emily Pang, Coby Schencker (lab partner)
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TA: Mithila Mangedarage
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DATA

Trial	Mass	Measurement 1	Measurement 2	Measurement 3	Average
1	m_1	0.2037	0.2036	0.2036	0.2036
	m_2	0.1965	0.1965	0.1966	0.1965
2	m_1	0.2435	0.2436	0.2435	0.2435
3	m_1	0.2836	0.2837	0.2836	0.2836
4	m_1	0.3238	0.3237	0.3238	0.3238
5	m_1	0.3639	0.3638	0.3638	0.3638

Table 1: Experiment 1 Masses (in kg)

Trial	Δp	ΔKE
1	-0.01	-0.0065
	-0.020	-0.017
	-0.0087	-0.019
2	-0.012	-0.013
	-0.0069	-0.024
	-0.014	-0.021
3	-0.0092	-0.010
	-0.010	-0.014
	-0.0096	-0.011
4	-0.0057	-0.013
	-0.0027	-0.019
	-0.0065	-0.0084
5	-0.0044	-0.0075
	-0.011	-0.0031
	-0.0060	-0.0069

Table 2: Experiment 1 Changes in Momentum and Kinetic Energy

Our lab consisted of an airtrack, two carts, two photogates, and varying masses. For the first experiment, the conservation of momentum and the conservation of energy were observed in an elastic collision. The second experiment examined the conservation of energy in an inelastic collision.

Question 1

PART A

The data and calculations for the first and second experiment are shown in Tables 1, 3, 4, and 6. For Experiment 1, the carts modeled an elastic collision, with rubber bands being used for the carts to deflect upon colliding. For the second experiment, an inelastic collision

Trial	Mass	Measurement 1	Measurement 2	Measurement 3	Average
1	m_1	0.2036	0.2036	0.2036	0.2036
	m_2	0.1964	0.1965	0.1966	0.1965
2	m_1	0.2436	0.2437	0.2437	0.2437
3	m_1	0.2838	0.2837	0.2838	0.2838

Table 3: Experiment 2 Masses (in kg)

Trial	Cart	v_i ($\frac{m}{s}$)	v_f ($\frac{m}{s}$)	p_i ($kg\frac{m}{s}$)	p_f ($kg\frac{m}{s}$)	KE_i (J)	KE_f (J)
1	m_1	-0.60	-0.04	-0.12	-0.016	0.037	0.00032
		-0.94	-0.17	-0.19	-0.068	0.090	0.0058
		-0.66	-0.19	-0.13	-0.076	0.044	0.0072
	m_2	0.52	-0.04	0.10	-0.016	0.027	0.00032
		0.32	-0.17	0.063	-0.068	0.010	0.0058
		0.22	-0.19	0.043	-0.076	0.0048	0.0072
2	m_1	-0.62	-0.18	-0.15	-0.079	0.047	0.0071
		-0.75	-0.19	-0.18	-0.084	0.069	0.0079
		-0.84	-0.22	-0.20	-0.097	0.086	0.011
	m_2	0.28	-0.18	0.055	-0.079	0.0032	0.0071
		0.40	-0.19	0.079	-0.084	0.0077	0.0079
		0.45	-0.22	0.088	-0.097	0.020	0.011
3	m_1	-0.92	-0.30	-0.26	-0.14	0.12	0.022
		-0.74	-0.24	-0.21	-0.12	0.078	0.014
		-0.84	-0.23	-0.24	-0.11	0.10	0.013
	m_2	0.43	-0.30	0.084	-0.14	0.018	0.022
		0.37	-0.24	0.073	-0.12	0.013	0.014
		0.52	-0.23	0.10	-0.11	0.027	0.013

Table 4: Experiment 2 Velocities, Momentums, and Kinetic Energies

was modeled, with the two carts sticking together using a pin.

PART B

In order to determine whether momentum and kinetic energy were conserved in each of the collisions, the difference in momentum at the start and finish of the experiment were calculated. These results for Experiment 1 are shown in Table 3. As referenced by the table, the values for the change in momentum are very close to the value of 0, giving evidence for the momentum and kinetic energy being conserved in elastic collisions. Additionally, the average Δp was 0.0091 and the average ΔKE was 0.013.

Experiment 2's results for change in momentum and kinetic energy are shown in Table 6. The average Δp was 0.027 and the average ΔKE was 0.079. Compared to Experiment 1, the average momentums and kinetic energies Experiment 2 are significantly more. While

Trial	Δp	ΔKE
1	0.0040	-0.063
	0.060	-0.094
	0.060	-0.042
2	0.017	-0.043
	0.021	-0.068
	0.019	-0.095
3	0.032	-0.12
	0.022	-0.077
	0.026	-0.11

Table 5: Experiment 2 Changes in Momentum and Kinetic Energy

Experiment 2's results support that the kinetic energy is not conserved, the results in the average change in momentum do not seem to support that momentum is conserved in inelastic collisions. Some errors could be due to the difficulty in ensuring the carts collided correctly (i.e. weren't passing through the speed sensors as they collided).

PART C

For Experiment 1, the coefficients of restitution are shown in Table 6. These values range from 0.88 to 0.94, which is fairly close to the expected 1 for perfectly elastic collisions. On average, the coefficient of restitution was 0.91, which is also fairly close to 1. Some factors that could contribute to these collisions not being closer to 1 could include the friction between the carts' rubber bands as they collided, or the friction from the differing distances (and thus the time friction acts on the carts during the experiment).

For Experiment 2, the velocities for $v_{1,f}$ and $v_{2,f}$ are equal, meaning that the coefficient of restitution for these collisions will always equal zero.

Trial	Cart	v_i ($\frac{m}{s}$)	v_f ($\frac{m}{s}$)	p_i ($kg\frac{m}{s}$)	p_f ($kg\frac{m}{s}$)	KE_i (J)	KE_f (J)	e
1	m_1	-0.45	0.36	-0.092	0.073	0.021	0.013	0.91
		-0.55	0.55	-0.11	0.11	0.031	0.031	0.89
		-0.79	0.47	-0.16	0.096	0.064	0.022	0.89
	m_2	0.44	-0.45	0.086	-0.088	0.019	0.020	0.91
		0.69	-0.55	0.14	-0.11	0.047	0.030	0.89
		0.59	-0.76	0.12	-0.15	0.034	0.057	0.89
2	m_1	-0.50	0.45	-0.12	0.11	0.030	0.025	0.90
		-0.65	0.50	-0.16	0.12	0.051	0.030	0.88
		-0.54	0.54	-0.13	0.13	0.036	0.036	0.89
	m_2	0.65	-0.59	0.13	-0.12	0.042	0.034	0.90
		0.74	-0.72	0.15	-0.14	0.054	0.051	0.88
		0.78	-0.63	0.15	-0.12	0.060	0.039	0.89
3	m_1	-0.48	0.34	-0.14	0.096	0.033	0.016	0.92
		-0.54	0.36	-0.15	0.10	0.041	0.018	0.91
		-0.48	0.38	-0.14	0.11	0.033	0.020	0.92
	m_2	0.59	-0.64	0.12	-0.13	0.034	0.040	0.92
		0.64	-0.71	0.13	-0.14	0.040	0.050	0.91
		0.64	-0.65	0.13	-0.13	0.040	0.042	0.92
4	m_1	-0.54	0.28	-0.17	0.091	0.047	0.013	0.91
		-0.58	0.31	-0.19	0.10	0.054	0.016	0.90
		-0.46	0.23	-0.15	0.074	0.034	0.0086	0.92
	m_2	0.61	-0.77	0.12	-0.15	0.037	0.058	0.91
		0.67	-0.81	0.13	-0.16	0.044	0.064	0.90
		0.51	-0.66	0.10	-0.13	0.026	0.043	0.92
5	m_1	-0.44	0.18	-0.16	0.065	0.035	0.0059	0.92
		-0.42	0.09	-0.15	0.033	0.032	0.0015	0.94
		-0.49	0.12	-0.18	0.044	0.044	0.0026	0.92
	m_2	0.49	-0.68	0.096	-0.13	0.024	0.045	0.92
		0.36	-0.64	0.071	-0.13	0.013	0.040	0.94
		0.43	-0.73	0.085	-0.14	0.018	0.052	0.92

Table 6: Experiment 1 Velocities, Momentums, and Kinetic Energies