

1) Collision kinematics

A particle 1 elastically collides with a particle 2 at rest. Show that for non-relativistic velocities the maximum transferred energy onto particle 2 is given by

$$E_2 = 4 E_1 m_2 / m_1 \text{ for } m_1 \gg m_2 \text{ and } E_2 = 4 E_1 m_1 / m_2 \text{ für } m_2 \gg m_1 .$$

a) What is the maximum transferred energy of an alpha-particle of 6 MeV onto an electron (assumed to be at rest)?

b) What is the maximum transferred energy in a collision of a 3-MeV electron with a Cu atom (at rest)? (be aware of the rest mass!)

2) Compton scattering.

At which energy is the backscattered γ -ray in the limit of high-energy γ -rays?

3) RBS analysis.

Sketch the energy spectrum of the RBS alpha particles (intensity versus energy) on a silicon disc (density of Si $\rho=2.33 \text{ g/cm}^3$) covered with a gold layer of $0.3 \mu\text{m}$ thickness (density of Au $\rho=19.3 \text{ g/cm}^3$), backscattered under 180 degree. The primary energy of the α – particles is 2 MeV. (Northcliffe and Schilling, ND Tables 7(1969) 233).

^4_2He IONS													
ENERGY PER MASS UNIT	RANGE IN UNITS OF MG/SQ CM												ENERGY FOR A=4
MEV/AMU	BE	C	AL	TI	NI	GE	ZR	AG	EU	TA	AU	U	MEV
0.0125	0.085	0.099	0.142	0.219	0.267	0.307	0.337	0.371	0.583	0.685	0.746	0.874	0.0500
0.0160	0.100	0.117	0.166	0.255	0.310	0.356	0.390	0.428	0.673	0.790	0.860	1.007	0.0640
0.0200	0.114	0.135	0.190	0.292	0.356	0.406	0.444	0.487	0.764	0.897	0.976	1.143	0.0801
0.0250	0.131	0.155	0.218	0.333	0.406	0.462	0.505	0.552	0.867	1.017	1.107	1.296	0.1001
0.0320	0.152	0.180	0.252	0.385	0.470	0.532	0.580	0.634	0.996	1.167	1.269	1.486	0.1281
0.0400	0.174	0.206	0.288	0.438	0.534	0.603	0.658	0.718	1.127	1.320	1.435	1.679	0.1601
0.0500	0.198	0.235	0.327	0.498	0.607	0.684	0.745	0.812	1.275	1.490	1.620	1.895	0.2001
0.0600	0.221	0.262	0.365	0.553	0.674	0.758	0.825	0.898	1.410	1.645	1.788	2.090	0.2402
0.0700	0.243	0.287	0.400	0.604	0.737	0.827	0.900	0.979	1.535	1.789	1.944	2.271	0.2802
0.0800	0.263	0.311	0.433	0.654	0.796	0.892	0.971	1.055	1.654	1.924	2.090	2.441	0.3202
0.0900	0.283	0.334	0.465	0.701	0.853	0.955	1.039	1.128	1.766	2.053	2.229	2.602	0.3602
0.1000	0.303	0.356	0.497	0.747	0.908	1.016	1.105	1.199	1.874	2.176	2.362	2.756	0.4003
0.1250	0.351	0.409	0.574	0.857	1.041	1.162	1.263	1.369	2.129	2.467	2.675	3.118	0.5003
0.1600	0.418	0.480	0.680	1.006	1.218	1.358	1.477	1.597	2.466	2.852	3.086	3.591	0.6404
0.2000	0.496	0.559	0.802	1.175	1.419	1.579	1.718	1.854	2.840	3.277	3.539	4.110	0.8005
0.2500	0.599	0.658	0.959	1.389	1.672	1.858	2.022	2.178	3.304	3.802	4.099	4.751	1.0007
0.3200	0.752	0.802	1.191	1.700	2.036	2.259	2.461	2.647	3.964	4.547	4.892	5.656	1.2808
0.4000	0.945	0.977	1.475	2.075	2.474	2.738	2.986	3.209	4.743	5.423	5.825	6.718	1.6010
0.5000	1.211	1.216	1.860	2.577	3.055	3.372	3.682	3.955	5.759	6.564	7.039	8.099	2.0013
0.6000	1.510	1.481	2.283	3.120	3.680	4.052	4.430	4.758	6.838	7.773	8.323	9.551	2.4016
0.7000	1.842	1.777	2.745	3.708	4.353	4.782	5.236	5.622	7.989	9.060	9.687	11.088	2.8018
0.8000	2.207	2.103	3.244	4.337	5.072	5.560	6.095	6.544	9.207	10.418	11.126	12.709	3.2021
0.9000	2.604	2.460	3.779	5.006	5.833	6.381	7.004	7.521	10.485	11.842	12.633	14.402	3.6023
1.0000	3.031	2.848	4.349	5.714	6.635	7.245	7.961	8.549	11.821	13.328	14.205	16.164	4.0026
1.2500	4.228	3.955	5.920	7.642	8.811	9.584	10.553	11.339	15.403	17.304	18.411	20.866	5.0033
1.6000	6.211	5.826	8.460	10.711	12.251	13.272	14.645	15.759	20.971	23.466	24.929	28.141	6.4042
2.0000	8.906	8.403	11.835	14.723	16.729	18.054	19.967	21.512	28.111	31.320	33.237	37.383	8.0052
2.5000	12.910	12.232	16.742	20.475	23.109	24.850	27.556	29.696	38.143	42.332	44.862	50.241	10.007
3.2000	19.669	18.656	24.857	29.860	33.450	35.850	39.838	42.951	54.141	59.869	63.338	70.594	12.808
4.0000	28.981	27.434	35.838	42.415	47.199	50.459	56.090	60.545	75.070	82.738	87.383	97.044	16.010
5.0000	42.903	40.463	52.011	60.740	67.151	71.624	79.576	85.969	104.928	115.401	121.564	134.555	20.013
6.0000	59.245	55.686	70.787	81.859	90.060	95.848	106.434	115.008	138.814	152.317	160.110	176.642	24.016
7.0000	77.926	73.019	92.063	105.656	115.831	123.000	136.481	147.486	176.530	193.264	202.825	223.087	28.018
8.0000	98.882	92.397	115.752	132.035	144.354	153.004	169.563	183.268	217.797	238.083	249.497	273.752	32.021
9.0000	122.021	113.778	141.783	160.909	175.528	185.766	205.590	222.233	262.558	286.598	299.989	328.433	36.023
10.0000	147.287	137.127	170.092	192.190	209.289	221.197	244.530	264.234	310.742	338.683	354.114	386.980	40.026
11.0000	174.648	162.394	200.627	225.799	245.552	259.221	286.299	309.135	362.231	394.145	411.613	449.291	44.029
12.0000	204.051	189.540	233.337	261.704	284.239	299.753	330.801	356.851	416.882	452.868	472.467	515.303	48.031