your names_____

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Physics 321 Exercise: Differential Scattering October 30, 2023

1. A neutron is incident on a target where it experiences a potential energy:

$$V(r) = \begin{cases} V_0, & r < R \\ 0, & r > R \end{cases}$$

   (a) (5 pts) If $V_0 = +\infty$, what is the total cross section?

   (b) (3 pts) If V_0 is positive, but finite, the cross section is
   - bigger.
   - smaller.
   - the same.

   (c) (2 pts) If V_0 is negative, but finite, the cross section is
   - bigger.
   - smaller.
   - the same.

2. You are an experimentalist and you have measured counts in your detector. The beam was neutrons scattering off a lead target. The mass density of lead is 11.29 gm/cm^3 and the mass of a lead atom is 3.44×10^{-22} g. The thickness of the target is 0.5 microns. You have 90 detector elements set at scattering angles of 2,4,6,$\cdots$,180 degrees. Each detector's cross sectional area is a 1 cm by 1 cm square, and is positioned 0.75 m from the target. A beam is aimed at the target, with 5×10^{12} neutrons impinging the target over the course of the experiment. Your detector elements have perfect efficiency and record the number of counts in the table below.

   (a) (5 pts) What is the angular coverage, $d\Omega$, of each detector element?

   (b) (5 pts) Calculate and plot $d\sigma/d\Omega$ in barns as a function of θ. (1 barn = 10^{-24} cm^2).

θ_s (deg)	counts
2.0	442730
4.0	438673
6.0	431988
8.0	422786
10.0	411222
12.0	397483
14.0	381791
16.0	364394
18.0	345558
20.0	325566
22.0	304704
24.0	283262
26.0	261520
28.0	239752
30.0	218211
32.0	197130
34.0	176719
36.0	157159
38.0	138604
40.0	121176
42.0	104968
44.0	90045
46.0	76441
48.0	64168
50.0	53212
52.0	43540
54.0	35099
56.0	27825
58.0	21639
60.0	16457
62.0	12187
64.0	8736
66.0	6010
68.0	3916
70.0	2366
72.0	1275
74.0	565
76.0	164
78.0	8
80.0	40
82.0	209
84.0	474
86.0	799
88.0	1153
90.0	1514
92.0	1864
94.0	2187
96.0	2476
98.0	2724
100.0	2927
102.0	3084
104.0	3196
106.0	3266
108.0	3296
110.0	3290
112.0	3253
114.0	3189
116.0	3102
118.0	2997
120.0	2877
122.0	2747
124.0	2610
126.0	2469
128.0	2326
130.0	2184
132.0	2044
134.0	1908
136.0	1778
138.0	1653
140.0	1535
142.0	1424
144.0	1321
146.0	1225
148.0	1137
150.0	1056
152.0	982
154.0	915
156.0	854
158.0	800
160.0	752
162.0	710
164.0	673
166.0	641
168.0	614
170.0	591
172.0	573
174.0	559
176.0	550
178.0	544
180.0	542