More Sample Final Problems

HW#7 is the practice for the relativistic quantum mechanics problem on the Final. There will also be a scattering problem and an identical particles problem.

① Born Approximation: $V(r) = \frac{Q}{4\pi a^2}\delta(r-a) - \frac{Q}{4\pi b^2}\delta(r-b)$

Assume $b > a$. Compute $\frac{d\sigma}{d\Omega} = |f(\theta)|^2$ in Born approximation and σ, the total cross section. Study the following cases:

(i) $\lambda \gg a$ and $\lambda \gg b$ and $\lambda \gg b-a$

(ii) $\lambda \gg a$, $\lambda \gg b$, $\lambda \ll b-a$

(iii) $\lambda \gg a$, $\lambda \sim b$ (requires $b \gg a$)

② Compute $\frac{d\sigma}{d\Omega}$ and σ in Born approximation for $V(r) = V_0\,\theta(a-r)$. Consider $\lambda \ll a$ and $\lambda \gg a$. Is the approximation accurate?

(3) Use the s-wave phase shift to estimate

or For: $V(r) = \infty \quad (r<a)$,

$V(r) = -V_0 \quad (a<r<b)$, $V(r)=0 \quad (r>b)$.

Study the limits in problem (1).

Note: use $u(r) = A \sin(kr - ka)$ for $a<r<b$

and $u(r) = B \sin(kr - \delta_0)$ for $r>b$.

(4) Two identical spin-½ Fermions are confined to a 1-d line $(0<x<a)$. Determine the gd. state and 1st two excited state energies and degeneracies. Compute the 1st order energy shift for $V(x) = -\alpha\,\delta(x - a/2)$ for these states. Most are zero.

(5) Three identical spin-0 bosons are confined to a 1-d line $(0<x<a)$. Same questions as in (4).

The problems on the final will be similar to these and the problems on the 2nd midterm.