

## Sample Midterm Problems (maybe more difficult than the exam)

- 1) Use the Born approximation to determine whether a weak spherical potential or a weak box ( $l^3$ ) potential of the same volume scatter more particles?
- 2) Compute the  $l=0$  phase shift & total cross section for an attractive spherical potential,  $V(r) = -V_0 \Theta(a-r)$ .
- 3) Compute the  $l=0$  phase shift & total cross section for a hard sphere of radius  $a$ .
- 4) A particle that satisfies the Klein-Gordon equation is confined in a  $l \times l \times l$  box. What are the allowed energies?
- 5) A Dirac Fermion experiences a potential:

$$V(\vec{r}) = \begin{cases} 0, & x < 0 \\ \infty, & x > 0 \end{cases} \quad \text{this is independent of } y \text{ and } z$$

- i) Try to find solutions with energy  $E$  assuming we need  $\psi(\vec{r}) = 0$  for  $x=0$ , independent of  $y$  and  $z$ .
- ii) Same as (i) using  $\hat{x} \cdot \vec{\alpha} \psi(\vec{r}) = \alpha_x \psi(\vec{r}) = 0$  at  $x=0$ , independent of  $y$  and  $z$ .