QUANTUM MECHANICS I

PHYS 516

Solutions to Problem Set # 1

1. Scaling: For hydrogen

$$E_g = -\frac{1}{2}mc^2\alpha^2 \qquad a_B = \hbar^2/me^2 \tag{1}$$

To compute the ground state energies for the bound systems in this problem replace the electron-proton reduced mass by the appropriate reduced mass. It is simpler to compute the ratio of the appropriate reduced mass to that of the p^+e^- reduced mass, and simply multiply 13.6 by this ratio. For the two excitons remember to divide by ϵ^2. For the size estimate you have to *divide* by the appropriate mass ratio. In the case of the excitons you must also multiply by ϵ.

Particle		A + B		A + B	
Mass MeV/c^2		Reduced M		Reduced M	
$e^{\pm}$	0.511	P^+e^-	0.5107	$\mu^+\mu^-$	105.7/2
$\mu^{\pm}$	105.7	$P^+\mu^-$	94.997	$\pi^+\pi^-$	139.6/2
$\pi^{\pm}$	139.6	$P^+\pi^-$	121.51	Si exc.	$0.511 * 0.2666$
p^+	938.2	e^+e^-	0.511/2	Ga exc.	$0.511 * 0.0595$

System	Energy (eV)	Size (Å)
p^+e^-	13.6	1.058 Å(diam.)
He^{II}:	54.4	0.529
$p^+\mu^-$	2529.6	0.00539
$p^+\pi^-$	3234.1	0.004449
e^+e^-	6.8	2.116
$\mu^+\mu^-$	1406.5	0.0102
$\pi^+\pi^-$	1857.6	0.007458
Si exc.:	0.02560	47.213
GaAs exc:	0.00518	221.99

2.& 3. Polarization: The plots below show the amplitudes $A(n)$ and the intensities $I(n) = |A(n)|^2$ for a series of equally rotated polaroid filters, each through an angle $(\pi/2)/n$, when the transmission probability (in intensity) is T. Light = amplitudes; Dark = intensities, for $T = 100\%, T = 90\%$.

$$A(n) = \left(\sqrt{T}\cos\frac{\pi/2}{n}\right)^n \qquad I(n) = |A(n)|^2$$

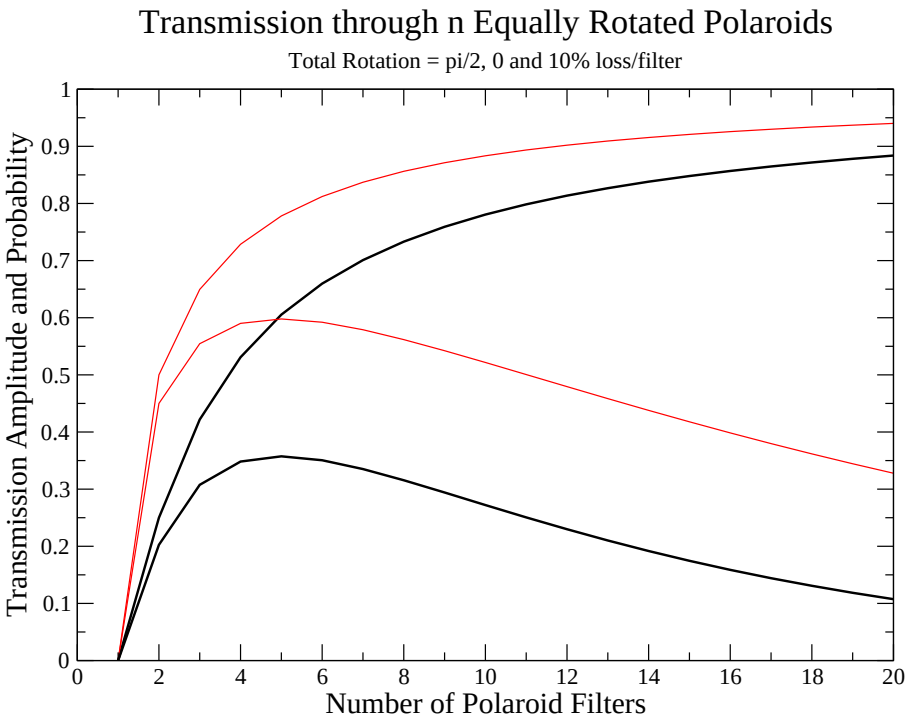

Figure 1: Light: transmission amplitude for 100% and 90% transmission per polaroid filter. Dark: transmission probability for the two cases.