Physics 262 Fall 2010 Exam #6 **No scantron today!** **Name** SOLUTIONS

$p = \frac{h}{\lambda}$ **If you need anything else, just ask!**

Please keep your answers to a couple sig figs.

1] A wavefunction for a particle is given by:

$\psi(x) = Ce^{-\kappa x}$, for x>0. The wavefunction is zero for x<0.

$\kappa = 40\ \text{nm}^{-1}$ .What is the value of *C* to properly normalize this wavefunction? (in $\text{nm}^{-1/2}$)

$$\int_0^\infty C^2 e^{-2\kappa x}\,dx = 0 \Rightarrow \frac{C^2}{2\kappa} = 1 \qquad C = \sqrt{2\kappa} = \sqrt{80} = 8.9\ \text{nm}^{-1/2}$$

2]. What is the probability (in percent) the particle will be found farther than 40 nm from x=0?

0.

3]. A particle is in the mixed wavefunction $\psi = C(4\psi_1 + 2\psi_2)$, where ψ_1 and ψ_2 are properly normalized stationary states of the potential.

What is *C*, for proper normalization of the mixed wave?

$$16C^2 + 4C^2 = 1 \qquad C^2 = \frac{1}{20} \qquad C = \frac{1}{\sqrt{20}} = 0.22$$

$$20C^2 = 1$$

4] If a measurement is made to determine what state this particle is in, which state is more probable?

(A] ψ_1) B] ψ_2 C] Both states are equally probable

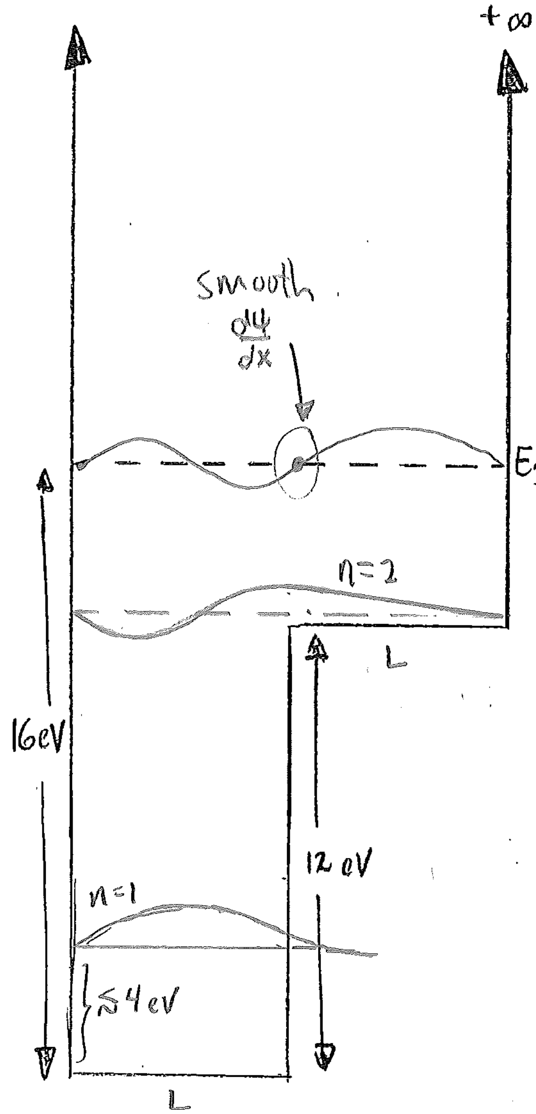
5] By what factor is the more probable state more probable than the less probable state?

4X

6] What is the probability (in percent) that the particle will be observed in state ψ_1?

80%

An infinite potential well has a different depth on its left and right sides, as shown.
Suppose the n=3 state has an energy that is 16 eV above the bottom of the well. The shelf of the well is 12 eV above the bottom.



7] How many "nodes" (zero crossings, not counting the ends) are there for the n=3 wavefunction? 2

8] If a free particle had the same energy as the n=3 state, in which part of the well would it have a larger momentum?
A] left side B] right side C] same in both sides

9] By what factor is the momentum larger, in the side where it is larger? 2 fold

Sketch the wavefunction for the n=3 state, using its energy as the ψ=0 line.

10] A measurement of the position of a particle in the n=3 state is made. Where is the particle most likely to be found?
A] left side of well B] right side of well C] both sides are equally likely

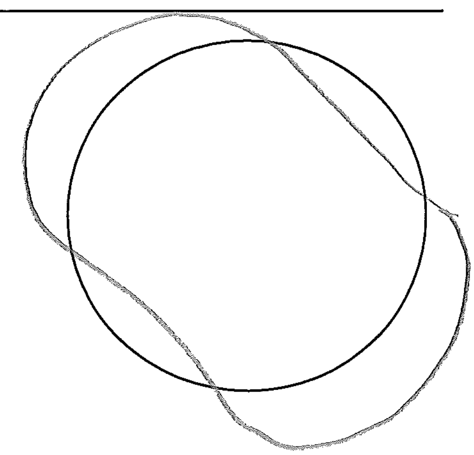
11] What is the approximate energy, in eV, of the n=1 state?
Since $E \propto n^2$, $E \simeq 4$ eV.

12] Is the actual energy of the n=1 state a little higher or lower than the answer to 11? A] higher B] lower C] 11 is exact

Sketch the wavefunction for the n=1 state using its energy as the ψ=0 line.

Extra credit: Sketch the n=2 state using its energy as the ψ=0 line. Is its energy higher or lower than the shelf?
2 pts.

Draw the n=2 Bohr wave on the orbit below.



13] Recall that Bohr orbits are consistent with the deBroglie wavelengths. Suppose a Roulette ball (mass 0.04 kg) moves around a roulette wheel (radius 0.3 m) once per second. In a bizarre alternate universe, this roulette ball is in the n=2 Bohr orbit. What is h?

Sketches will count for 3 points (total).

$$mv = m\cdot\frac{2\pi r}{T} = \frac{h}{\lambda}$$

$$\lambda = \pi r$$

so $h = m\cdot\frac{2\pi^2 r^2}{T} = 0.071$ J.s.