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**Answer Sheet: Chemistry 6854 Take Home Exam 1: \_\_\_\_\_\_\_/90 pts**

**Your name:**

***You can attach more pages if the spaces below are insufficient for you to show your work***

**Problem 1: Black Body Model (10 pts)**

1a) Temperature the tungsten operating at to reach 500 nm color: \_\_\_\_\_\_\_\_\_K (3 pts)

1b) In qualitative terms describe what the problem is with the classical Rayleigh-Jeans prediction of the

energy density emitted by a black body. Be sure to include why this problem is often called “the

ultraviolet catastrophe.” (3 pts)

1c) In qualitative terms, describe why the photoelectric effect experiment caused such enormous problems

for the classical theory that light is a wave. (4 pts)

**Problem 2: Bohr’s Model (part 1) (15 pts)**

Using the Bohr model :

Derive a general expression for the momentum (m\*v) of an electron in the Bohr atom (12 pts)

Final form form mv(kg\*m/s) =

1. mv(kg\*m/s) an electron around the H atom at n= 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kg\*m /s 3 pts

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**Problem 3: Bohr’s Model (part 2) (15 pts)**

1. Re-derive Bohr’s total energy E for the electron for the case of Z>1. ( 10 pts)
2. Element producing the n=4 🡪 n=1 emission occurs at 10.8061 nm. \_\_\_\_\_\_ (5 pts)

**Problem 4: Uncertainty and Measurement (5 pts)**

**Circle choice: Butt kick Beer**

Provide a rationale for your choice below:

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**Problem 5: Old School Physics and the Homogenous, 2nd order Differential Method (25 pts)**

1. Re-derive the specific solution to md2x/dt2= -kx - γdx/dt in the form:

x(t)= C1 e-atcos bt +C2e-atsin bt

Assumed Conditions and substitutions

1/T = γ/m and ωo2=k/m dx/dt=vo at t=0 x(t)= 0 at t=0 (γ/m)2- 4(k/m) < 0

(hint: remember that c1eiθ + c2e-iθ = C1cos θ + C2 sin θ and apply boundary conditions) 15 pts

1. Given that vo = 1, T=0.25, ωo =√101 what is the exact form of the solution to x(t) ? 6 pts

Exact form with values given: x(t)=

1. Attach exact solution above for the case of T=0.25, ωo =√101 for t= 0🡪π/2 using Maple. 4 pts

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**Problem 6: The particle in a less-than-perfectly symmetric 2D Box (10 pts)**

a) final energy for the system with Lx = ½ Ly 5 pts

E(nx, ny) =

b) HOMO->LUMO transition wavelength λ(nm) for the above assuming 18 electrons

λ (HOMO🡪LUMO)= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_nm 5 pts

**Problem 7: benzene as a particle in a circle (10 pts)**

The ***observed*** HOMO🡪 LUMO uv transition for gas phase benzene occurs at 180 nm *(Takahashi, J. Chem. Phys. 57(6) 1972 pp 2526-2531).* Provide evidence-yea or nay- that the particle-on-a-circle model for benzene is a reasonable one . You can assume that the ~ radius of benzene to be 0.2 nm (2\*10-10m) and that only its π electrons move freely. 10 pts