Name:	Signature:
Surname:	Number:

KOÇ UNIVERSITY

College of Sciences
PHYS 206/456 General Phyisics IV
Spring Semester 2013
Midterm Examination 2
April 25, 2013 Thursday, 18:30-20:30

Please read.

- Count to make sure that there are 7 pages in this question booklet
- Check your **name, number, on front page, and student ID on each page and sign each page.**
- This examination is conducted with closed books and notes.
- You are allowed to use calculators.
- Put all your personal belongings underneath your seat and make sure that pages of books or notebooks are not open.
- Absolutely no talking or exchanging anything (like calculators, rulers, erasers) during the exam.
- You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct).
- Write neatly and clearly; unreadable answers will not be given any credit.
- If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
- Make sure that you include units in your results.
- Make sure that you label the axis and have units in your plots.
- Turn off your mobile phones, and put away.
- You are not allowed to leave the class during the first 15 minutes.

Useful Constants:

$e = 1.60 \times 10^{-19} C$
$h = 6.63 \times 10^{-34} J.s$
$m = 9.11 \times 10^{-31} kg$
$c = 3.00 \times 10^{8} m/s$

Index:

1	2	3	4	5	6	Total

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1-(20 Points) (a) Through what potential difference does an electron have to be accelerated, starting from rest, to achieve a speed of 0.980c ?
(b) What is the kinetic energy of the electron at this speed? Express your answer in joules and in electron volts.

Solution continues on the back side of the page **Yes** □ **No** □

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2-(15 Points) A cube of metal with sides of length *a* sits at rest in a frame *S* with one edge parallel to the x-axis. Therefore, in *S* the cube has volume a^3. Frame *S'* moves along the x-axis with a speed $u=0.8c$ relative to *S*. As measured by an observer in frame *S'* what is the volume of the metal cube?

Solution continues on the back side of the page **Yes** □ **No** □

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3-(15 Points) When ultraviolet light with a wavelength of 254 nm falls on a clean copper surface, the stopping potential necessary to stop emission of photoelectrons is 0.181 V.

(a) What is the photoelectric threshold wavelength for this copper surface?

(b) What is the work function for this surface?

Solution continues on the back side of the page **Yes** □ **No** □

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4-(15 Points) Using Bohr model, find relations for the orbital radius, orbital speed, and orbital energy for an electron in n^{th} energy level of the hydrogen atom. (You need to derive these relations. No credit will be given if you directly write these relations without any derivation.)

Solution continues on the back side of the page **Yes** □ **No** □

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5-(20 Points) When a hydrogen atom undergoes a transition from the $n=2$ to $n=1$ level, a photon with wavelength $\lambda=122\ nm$ is emitted.

(a) If the atom is modeled as an electron in a one-dimensional box, what is the width of the box in order for the $n=2$ to $n=1$ transition to correspond to emission of a photon of this energy?

(b) For a box with the width calculated in part (a), what is the ground-state energy? How does this correspond to the ground-state energy of a hydrogen atom?

(c) Do you think one-dimensional box is a good model for a hydrogen atom? Explain.

(Hint: Compare the spacing between adjacent energy levels as a function of n.)

Solution continues on the back side of the page **Yes** □ **No** □

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6-(15 Points) Show by direct substitution in the Schrödinger's equation for the one-dimensional harmonic oscillator ($U(x) = \frac{1}{2}k'x^2$) that the wavefunction $\psi_1(x) = A_1 x\, e^{-\alpha^2 x^2/2}$, where $\alpha^2 = m\omega/\hbar$ and $\omega = \sqrt{\frac{k'}{m}}$ is a solution with energy corresponding to *n=1* in $E_n = (n + 1/2)\hbar\omega$.

Solution continues on the back side of the page **Yes** □ **No** □