Physics 1BA3 **Test #2** **1 hour**
March 2003

Name:
Number:
Section: 8:30 9:30 11:30

This paper consists of 5 questions. Show your work for each question in the space provided (it will be marked). Circle the correct answer and transfer your choice to the last page.

gravitational field at earth's surface	$g = 9.81\ m/s^2$
speed of light in vacuum	$c = 3.00 \times 10^8\ m/s$
Planck's constant	$h = 6.63 \times 10^{-34}\ J\text{-}s$
charge of electron	$-e = -1.602 \times 10^{-19}\ C$
mass of the electron	$m_e = 9.109 \times 10^{-31}\ kg$
mass of the hydrogen atom	$m_H = 1.67353 \times 10^{-27}\ kg$
mass of the neutron	$m_n = 1.67492 \times 10^{-27}\ kg$
Coulomb's law constant	$k_e = [4\pi\varepsilon_0]^{-1} = 9 \times 10^9\ Nm^2/C^2$
Bohr radius	$a_0 = 0.0529\ nm$
$\int \sin(ax)\,dx = -(\cos(ax))/a$	$amu = 931.494013\ MeV/c^2$
$\int \sin^2(ax)\,dx = x/2 - (\sin(2ax))/(4a)$	
$\int \cos^2(ax)\,dx = x/2 + (\sin(2ax))/(4a)$	

Moment of inertia of a long thin uniform stick about its middle = $M L^2 / 12$
Moment of inertia of a disk about its axis = $M R^2 / 2$
Moment of inertia of a ring about its axis = $M R^2$

$\mathbf{I = I_{cm} + m\,d^2}$
$\mathbf{I = \int r^2\,dm}$
$V = k_e\, q / r$
$r_n = n^2\, a_0$
$\mathbf{F} = k_e\, q_1 q_2 / r^2$
$\mathbf{F} = q\,\mathbf{v} \times \mathbf{B}$
$\mathbf{F} = q\,\mathbf{E}$
$\mathbf{F} = m\,\mathbf{a}$
$L = I\,\omega$
$\tau = I\,\alpha$
$N = N_0\, e^{-\lambda t}$

$\Delta x\, \Delta p_x >= h / 4\pi$
$\lambda' - \lambda_0 = h(1 - \cos\theta) / (m c)$
$E_n = -13.6 / n^2\ eV$
$E_n = n^2 h^2 / (8\, m\, L^2)$

$\lambda = h / p$
$c = f\lambda$
$E = h f$
$hf = \Phi + K_e^{max}$
$E_b = (Z\, m_H + N\, m_n - M_A)\, c^2$
$\lambda\, T_{1/2} = 0.693$

1. Three identical particles of charges Q and masses M are initially placed on the points of an equilateral triangle with side L. One of the charges is released while the other two remain fixed. Find the velocity of the released charge at infinity.

a) $2Q\sqrt{\frac{k_e}{L^2M}}$

a) $3Q\sqrt{\frac{L^2M}{k_e}}$

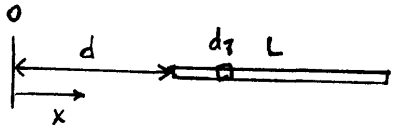
c) $2Q\sqrt{\frac{k_e}{LM}}$

d) $3Q\sqrt{\frac{k_e}{LM^2}}$

e) None of the above

2. A thin stick of length L has a non-uniform charge density $\lambda = \alpha x$ C/m, where α is a constant and x is the distance from the origin. Find the electric potential at the origin.

a) $k\alpha \ln[(d+L)/L]$
b) $k\alpha L$
c) $k\alpha(L+d)$
d) $k\alpha^2 \ln[(d+L)/L]$
e) None of the above



3. Photoelectrons ejected from a surface by light of wavelength 500 nm are stopped by a potential difference of 0.90 V. What potential difference is required to stop electrons ejected by light of λ = 350 nm.

a) 1.97 V
b) 2.53 V
c) 0.46 V
d) 0.05 V
e) None of the above

4. A photon with energy E_p undergoes a head-on collision with a free electron, i.e., it scatters and reverses its direction. In this process, the magnitude of the change in wavelength is $\Delta\lambda$. Find an expression for the fractional change in wavelength $\Delta\lambda / \lambda_o$ in terms of the mass of the electron m_e, the original energy of the photon E_p and c.

a) $E_p / (m_e c^2)$
b) $2 E_p / (m_e c^2)$
c) $m_e c^2 / E_p$
d) $2 m_e c^2 / E_p$
e) None of the above

5. Two hydrogen atoms, each with speed v, collide head-on and end up with zero kinetic energy. The atoms are both excited to their first excited states. Both atoms then decay by the emission of 121.6 nm photons. Calculate the initial speed v of the atoms.

a) 4.43×10^4 m/s
b) 7.22×10^3 m/s
c) 8.59×10^4 m/s
d) 1.06×10^5 m/s
e) None of the above

Transfer your answers here:

1. a) b) c) d) e)

2. a) b) c) d) e)

3. a) b) c) d) e)

4. a) b) c) d) e)

5. a) b) c) d) e)