REVIEW FINAL EXAM PHYSICS 4

1/ Consider a particle moving in one dimension, which we shall call the *x*-axis.
(a) What does it mean for the wave function of this particle to be *normalized* ?
(b) If the particle described by the wave function $\psi(x) = Ae^{bx}$, where *A* and *b* are positive real numbers, is confined to the range $x \geq 0$, determine *A* (including its units) in function of *b* so that the wave function is normalized.

2/ (a) The orbital angular momentum of an electron has a magnitude of $L = 4.716 \times 10^{-34} kg.m^2/s$. What is the angular-momentum quantum number *l* for this electron ?
(b) Make a chart showing all the possible sets of quantum numbers *l* and m_l for the states of the electron in the hydrogen atom when *n* = 5. How many combinations are there ? What are the energies of these states?

3/ (a) The uncertainty in the y-component of a proton's position is $2.0 \times 10^{-12}\,\text{m}$. What is the minimum uncertainty in a simultaneous measurement of the y-component of the proton's velocity ?
(b) The uncertainty in the z-component of an e1ectron's velocity is 0.250 m/s. What is the minimum uncertainty in a simultaneous measurement of the z-coordinate of the electron ?

4/ Consider a wave function given by ψ(x) = Asinkx, where $\text{k} = \frac{2\pi}{\lambda}$ and A is a real constant.

(a) For what values of x is there the highest probability of finding the particle described by this wave function ? Explain.
(b) For which values of x is the probability zero ? Explain.

5/ Knowing that the energy of a particle of mass m in a one-dimension box is given by $\text{E} = \frac{\text{h}^2}{8\text{mL}}\text{n}^2$, where L is the width of the box and n is an integer.
(a) Find the excitation energy from the ground level to the third excited level for an electron confined to a box that has a width of 0.125 nm.
(b) The electron makes a transition from the n = 1 to n = 4 level by absorbing a photon. Calculate the wavelength of this photon.

6/ Consider the nuclear reaction ${}^4_2\text{He} + {}^7_3\text{Li} \rightarrow {}^{\text{A}}_{\text{Z}}\text{X} + {}^1_0\text{n}$ where X is a nuclide.
(a) How many protons and neutrons are there in the nuclide X ?
(b) Calculate the energy (in MeV) of this reaction ?

7/ The mass of ${}^4_2\text{He}$, ${}^7_3\text{Li}$, ${}^{\text{A}}_{\text{Z}}\text{X}$, and ${}^1_0\text{n}$ is, respectively, 4.002603u, 7.016003u, 10.811100u, and 1.008665u, with $1\text{u} = 931.5\text{MeV}/\text{c}^2$.
7/ Measurements on a certain isotope tell you that the decay rate decreases from 8318 decays/min to 3091 decays/min in 4.00 days. What is the half-life of this isotope?

8/ Consider two observers, O and O', where O' travels with a constant velocity *v* with respect to O along their common *x*-*x'* axis.

(a) A meterstick makes an angle of 30° with respect to the *x'*-axis of O'. What must be the value of *v* if the meterstick makes an angle of 45° with respect to the *x*-axis of O.

(b) What is the length of the meterstick as measured by O'?

9/ A proton (rest mass $1.67\times10^{-27}\,\text{kg}$) has total energy that is 4.00 times its rest energy. What are

(a) the kinetic energy of the proton;

(b) the speed of the proton?

10/ An electron has a velocity v = 0.990c.

(a) Calculate the kinetic energy in MeV of the electron.

(b) Compare this with the classical value for kinetic energy at this velocity. What is your observation?

The mass of an electron is $9.11\times10^{-31}\,\text{kg}$.