1. (16%)Please explain briefly the following terms:
   (A) Binding energy
   (B) Wave-particle duality
   (C) Electron spin
   (D) Nuclear fission

2.(3%) Computer assisted tomography (CAT) uses which of the following radiation source to scan
   (A) Infrared
   (B) UV light
   (C) γ-ray
   (D) X-ray
   (E) β-radiation

3.(3%) Positron emission tomography (PET) detects which of the following radiation
   (A) Infrared
   (B) UV light
   (C) γ-ray
   (D) X-ray
   (E) β-radiation

4. (8%) This year is the World Year of Physics. Which three papers did Einstein write a hundred years ago in 1905? For which contribution was he awarded Nobel Prize in 1921? Describe briefly its principle.
   (A) Special relativity
   (B) General relativity
   (C) Brownian motion
   (D) Photoelectric effect
   (E) Light quanta

5. (5%) If particles can tunnel through energy barriers, do you think a tiger can get out of its cage if it keeps bumping on it?

6. (15%) Using your knowledge about modern view of atomic structure (atom and nuclear), please explain the origin of line spectra, including fine structure, and hyperfine structure.(You may ignore X-ray.)

7. (20%) The proper mean lifetime of pions is 2.6×10^{-8} s. If a beam of such particles has speed 0.9 c,
(A) What would their mean life be as measured in the laboratory?
(B) How far would they travel (on the average) before they decay?
(C) What would your answer to part b) if you neglect time dilation?
(D) What is the interval in spacetime between creation of a typical pion and its decay?

8. (15%) (A) Describe briefly how X-ray can be generated in a laboratory. Name two applications that use X-ray. (B) In a conventional laboratory X-ray generator, what is the λ_{min} when a 20 keV voltage is applied on the electrons? (C) Explain briefly why there are sharp lines in X-ray spectra sometimes when laboratory X-ray generator is used? (hc=1240 eV·nm)

9.(15%) An electron in an infinite square well with $L=10^{-12}$m is moving at relativistic speed. (A) Use the uncertainty principle to verify that the speed is relativistic. (B) Derive an expression for the electron's allowed energy levels and compute E_1. (C) By what fraction does E_1 computed in (B) differ from nonrelativistic E_1? ($m_e=0.511 MeV/c^2$)