KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2008/2009 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHYS 413

COURSE TITLE: NUCLEAR PHYSICS

STREAM: SESSION VII

DAY: THURSDAY

TIME: 2.00 – 4.00 P.M.

DATE: 12/08/2010

INSTRUCTIONS:

1. *Answer question **1** and any other **two** questions*
2. *Question 1 carries **40** marks and the others carry **15** marks each.*
3. *You may find the following information useful;*
   a. *Electronic charge $e = 1.602 \times 10^{-19} C$*
   b. *Avogadro's number $N = 6.022 \times 10^{23} mol^{-1}$*
   c. *Planck's constant $h = 6.63 \times 10^{-34} Js$*
   d. *Velocity of light $C = 3.0 \times 10^{8} ms^{-1}$*
   e. *1 a.m.u. $= 1.66 \times 10^{-27} kg = 931.5 MeV$*
4. *Rest mass and energy of particles;*
   a. *Neutron (n) $m = 1.6749 \times 10^{-27} kg = 1.0087$ a.m.u.*
   b. *Proton (p) $Mp = 1.6726 \times 10^{-27} kg = 1.0078$ a.m.u.*
   c. *Electron (e) $Me = 9.1 \times 10^{-31} kg = 0.000548$ a.m.u*
   d. *Deuterium ${}_1H^2$ (2.0141 a.m.u), ${}_1H^3$ (3.0160 a.m.u) ${}_{92}U^{235}$ (235.044 a.m.u), ${}_{56}Ba^{141}$ (140.914 a.m.u), ${}_{82}Pb^{214}$ (205.974 a.m.u.), ${}_{86}Rn^{222}$(220.011 a.m.u), ${}_{27}Co^{59}$ (58.933198a.m.u), ${}^{12}_{6}C$ (12.0000a.m.u), ${}^{13}_{7}N$ (13.005738a.m.u),*
5. *${}^{210}_{84}Po$ (209.98285a.m.u), ${}^{206}_{82}Pb$ (205.97440a.m.u) and ${}^{4}_{2}He = 4.002604$ a.m.u*

PLEASE TURN OVER

QUESTION 1 (40 marks)

a.) An atom of Lithium contains 3 electrons, 3 protons and 4 neutrons. Calculate its nucleon number. (2 marks)

b.) A nucleus consists of 90 protons and 144 neutrons. It emits two beta particles followed by an alpha particle. Determine the number of its nucleons after this reaction. (3 marks)

c.) What changes take place the mass and charge of the nucleus of an atom if it emits (i) an α-particle, (ii) a β-particle, (iii) a γ-ray? (3 marks)

d.) $^{220}_{86}Rn$ emits α-particle and it becomes an isotope of the element polonium (Po). Write an equation to represent this change. (2 marks)

e.) Show that 1 u = 931.5 MeV if 1 u = 1.66054×10^{-27}kg. (2 marks)

f.) i.) what is background count? (1 mark)
ii) Give two sources of background count (2 marks)

g.) A proton released in a nuclear reaction moves in a circular path perpendicular to a uniform magnetic field of 0.43T. The kinetic energy of the particle is 0.66 MeV. What is the radius of the circle? (3 marks)

h.) Give one advantage and one disadvantage of fusion power generation. (2 marks)

i.) What is the approximate volume of the nucleus of $^{138}_{56}Ba$ given that r_o = 1.3fm? (2 marks)

j.) State two ways in which γ-ray are absorbed by materials. (2 marks)

k.) How much energy is released in the fusion $^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He$ (4 marks)

l.) Give two medical applications of radioisotopes. (2 marks)

m.) A student observes a count rate of 8576 counts per min in a specimen of radioactive Ba that has a half-life of 2.5 min.

i.) How long must the student wait before the count-rate drops to below 100 counts/min? (3 marks)

ii.) Calculate the mean life of Ba. (2 marks)

n.) Define neutrinos (1 mark)

o.) Why should the applied potential difference in a GM tube not exceeding plateau value? (2 marks)

p.) Give two ways of reducing radiation exposure. (2 marks)

QUESTION TWO (15 MARKS)

a.) A radioactive process occurs when the mass of the products is less than that of the original starting mass.

i.) What name is given to the difference in the mass stated above? (1 mark)

ii.) $^{210}_{84}Po$ decays by emission of an alpha particle to $^{206}_{82}Pb$, find the kinetic energy released in this process. (4 marks)

b.) Show that mean-life of a radioisotope is given as $\bar{T} = \frac{1}{\lambda}$ (5marks)

c.) The disintegration constant λ of a radioactive element is 0.0056 per year. Calculate its half-life and average life. (3 marks)

d.) Give two disadvantages of GM counter. (2 marks)

QUESTION THREE (15 MARKS)

a.) Define magic numbers and give two examples of these numbers. (2 marks)

b.) With a well labeled diagram, describe the operations of a nuclear reactor. (8marks)

c.) Show that alpha disintegration energy E is given as, $E = \frac{1}{2}mv^2\left(1+\frac{m}{M}\right)$

The initials have there normal meaning. (3 marks)

d.) Give the difference between line spectrum and continuous spectrum. (2 marks)

QUESTION FOUR (15 MARKS)

a.) The number of particles counted per second from a certain sample of a material, which radiates alpha-particles, is recorded regularly for a period of time. The measurements are given below. Use these figures to determine the half-life of the material.

Time/hours	0	1	2	3	4
Number per second	500	305	186	118	62

(7 marks)

b.) Give two effects of exposure to radioactive sources by human beings. (2 marks)

c.) Explain why decay rate of radioactive nuclei is not changed by heating. (2 marks)

d.) Radioactive iodine-131 has a half-life of 8 days and an initial activity of $3.6\text{x}10^7$ Bq. What will be the activity after 45 days? (4 marks)