

KABARAK

UNIVERSITY

UNIVERSITY EXAMINATIONS

2010/2011 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF SCIENCE IN EDUCATION SCIENCE

COURSE CODE: CHEM 422

COURSE TITLE: RADIATION AND NUCLEAR

CHEMISTRY

STREAM: Y4 S2

DAY: SATURDAY

TIME: 9.00 – 11.00 P.M

DATE: 27/11/2010

INSTRUCTIONS: Attempt all questions Total marks = 70 (Each = 17.5) Periodic table and Graph paper provided. Mass of particles are, 1proton = 1.0073 amu, 1 neutron = 1.0087 amu and 1 electron = 0.00054858), 1 joule = 1 kg.m²/s², 1 amu = 1.66056520 x 10⁻²⁴ gm

PLEASE TURN OVER

1(a) (i) State the law of conservation of mass – energy.

(ii) Explain the term mass deficiency?

(b) (i) Define binding energy.

(ii) Explain the relationship between mass deficiency and binding energy?

(5 marks)

(4marks)

- (c) The actual mass of a 64 Zn atom is 63.9291 amu. (Atomic No. for Zn = 30)
 - (i) Calculate the mass deficiency in amu per atom and in grams per mole for the isotope.
 - (ii) Calculate the binding energy in Kj per mole for this isotope? (8.5 marks)
- 2. (a) Compare the behaviour of α, β, γ radiation in (i) an electric field (ii) In magnetic field and (iii) with various shielding materials. (7 marks)
 - (b) Radio- actinium is produced in the actinium series from ${}^{235}{}_{92}$ U by the successive emission of an α -particle, a β^{-} particle, an α -particle and a β^{-} particle. Give the symbol, atomic number, and mass number for radio-actinium?

(2.5 marks)

- (c) A sample of waste a radioactivity, caused solely by strontium -90 (beta emitter, $t_{1/2} = 28.1$ years), of 0.245 Ci per gram. Calculate the number of years it will take for its activity to decrease to 1.00 x 10⁻⁶ Ci per gram? (4 marks)
- (d) Calculate the decay constant (λ) for a radioactive sample of ³⁷Ar radioisotope when it takes 100 days for 86.3% of the atoms to decay. (4 marks)
- 3. (a) (i) Explain what is meant by half life of a radiation?(ii) Explain what is meant by activity of a radiation? (4marks)
 - (b) Technetium-99 (gamma emitter, $t_{1/2}$ is 6.02 hrs) is widely used for diagnosis in medicine. A sample prepared in the early morning for use that day had an activity of 4.52 x 10⁻⁶ Ci. Calculate its activity by the end of 8 hrs.

(6 marks)

(c) The following data were collected for a half-life determination of a radioactive sample:

Activity (cpm)	Time (sec)
1360	60
910	180
694	300
463	420
351	540
232	660
140	780

Use simple decay curve method to determine (i) the half-life (ii) the original activity of the sample. (7.5 marks)

- 4. (a) (i) Explain the following terms: Nuclear fusion and nuclear fission and give Examples of each.
 - (ii) Explain why it is easier for a nucleus to capture a neutron than a proton?

(6 marks)

- (b) (i) What is chain reaction? Give an example.
 - (ii) Name four devices that are used to detect nuclear radiation. (6 marks)
- (c) (i) Explain why an alpha emitter is not used in diagnostic work?
 - (ii) The ratio of carbon-14 to carbon -12 is constant in living organism but changes after the organism dies. Explain why it is constant during life?
 - (iii) In the late 1940s, many manuscripts were found in caves near the northwestern corner of the Dead Sea region of the middle East, and they came to be called the dead sea scrolls. Some were made of copper but others were of parchment. When one parchment scroll was analyzed by the carbon-14 dating method, its specific activity was found to be 0.175 Bq g⁻¹. Calculate the age of the scroll. $(t_{1/2} \text{ for } ^{14}\text{C} = 5730 \text{ years})$ (5.5 marks)