11.4 - Nuclear Physics

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- (1998) Explain the terms: atomic mass unit, mass defect, packing fraction and binding energy.
- (1998) Discuss carbon dating.
- (1998) Find the age at death of an organism, if the ratio of amount of C14 at death to that of the present time is 10^8 and that the half life of Cl4 is 5600 years.
- (1999) What is nuclear fusion
- (1999) What is nuclear fission?
- (1999) Define the term binding energy of a nuclide.
- (1999) Distinguish between:
  - $\beta-$ decay and $\beta+$ decay.
  - nuclear fission and nuclear fusion
  - activity and half-life of a radioactive material.
  - Taking the half-life of Radium -226 to be 1600 years, what fraction of a given sample remains after 4800 years?
- (2000) A sample of soil from Olduvai Gorge cave was examined. It was found to contain, among other things, pieces of charcoal. Further investigation on the charcoal revealed that 1 kg of C14 nuclei decayed each second. It is assumed that this charcoal has resulted from decomposition of the stone-age people who died there (i.e. at the cave) long time ago. Calculate the number of years that have elapsed since these people died.
- (2007) It is not possible to separate the different isotopes of an element by chemical means. Explain.
- (2007) Define a mass spectrometer.
- (2007) Ion A of mass 24 and charge $+e$ and ion B of mass 22 and charge $+2e$ both enter the magnetic field of a mass spectrometer with the same speed. If the radius of A is $2.5 \times 10^{-1} m$, calculate the radius of the circular path of B .
- (2007) If the ratio of mass of lead 206 to mass of uranium 238 in a certain rock was found to be 0.45 and that the rock originally contained no lead 206 , estimate the age of the rock given that the half life of uranium 238 is 4.5×10^9 years.
- (2007) Define the following terms:

  - Atomic mass unit
  - Binding energy
  - Mass defect.

- (2009) Explain the following observations:
  - A radioactive source is placed in front of a detector which can detect all forms of radioactive emissions. It is found that the activity registered as noticeably reduced when a thin sheet of paper is placed between the source and detector.
  - When a brass plate with a narrow vertical shit is placed in front of the radioactive source (above) and a horizontal: magnetic field normal to the line joining the source and the detector is applied, its found that the activity is further reduced.
  - The magnetic field (above) is removed and a sheet of aluminum is placed in front of the source. The activity recorded is similarly reduced.

- (2009) A 2.71 g sample of Kcl from the chemistry stock is found to be radioactive and decays at a constant rate of 4490 disintegrations per second. The decays are traced to the element potassium and in particular to the isotope ^{40} K which constitutes 1.17% of normal potassium. Calculate the half life of the nuclide.

- (2013) Distinguish between white spectrum and line spectrum.

- (2013) What is the significance of the binding energy per nucleon?

- (2013) Briefly explain why the β particles emitted from a radioactive source differ from the electrons obtained by thermionic emission?

- (2013) The mass of a particular radioisotope in sample is initially 6.4×10^{-3} kg, After 42 days the isotope was separated from the sample and found to have a mass of 1.0×10^{-4} kg. Calculate the half- life of the isotope.

- (2015) Define activity and half-life.

- (2015) The half-life of radioactive substance is 1 hour. How long will it take for 60% of the substance to decay?

- (2015) What is a nuclear reactor?
  - Briefly explain any three main components in a nuclear reactor.

- (2015) Sketch the binding energy curve.
  - State any two conclusions that can be drawn from the curve above.

- (2015) If the mass of deuterium nucleus is 2.015 a.m.u, that of one isotope of helium is 3.017 a.m.u. and that of neutron is 1.009 a.m.u., calculate the energy released by the fusion of 1 kg of deuterium.
  - Suppose 50% of this energy was used to produce 1 MW of electricity, for how many days would be able to function.

- (2016) The number of particles n crossing a unit area perpendicular to $x-$ axis in a unit time is given as $n = -D(n_2 - n_1)/(x_2 - x_1)$ where n_1 and n_2 are the number of particles per unit volume for the values of x_1 and x_2 respectively. What are the dimensions of diffusion constant D ?
- (2016) Differentiate natural radioactivity from artificial radioactivity.
- (2016) Name three applications of radioisotopes in medicine.
- (2016) State two conditions for stability of nuclides referring to light nuclides and heavy nuclides.
- (2016) Derive an expression for the half-life using the radioactive decay law.
- (2016) What is carbon -14 ? Explain its production and how it is used in the dating process.
- (2016) Living wood has an activity of 16.0 counts per minute per gram of carbon. A certain sample of dead wood is found to have an activity of 18.4 counts per minute for 4.0 grams. Calculate the age of the sample of dead wood. Assume the half-life of carbon -14 is 5568 years.
- (2017) What is meant by the following?
  - Atomic Mass Unit (a.m.u.)
  - Binding energy.
  - Mass defect
- (2017) Write down the equation for the disintegration.
- (2018) Use the concept of radioactive decay and nuclear reactions to define the following terms:
  - α decay
  - β decay
  - γ decay
  - Fission
  - Fusion.
  - For each of the terms above, give one suitable reaction equation.
- (2018) A freshly prepared sample of a radioactive isotope Y contains 10^{12} atoms. The half-life of the isotope is 15 hours. Calculate;
  - the initial activity.
  - the number of radioactive atoms of Y remaining after 2 hours,
- (2018) Mention any four important features in the design of a nuclear reactor.
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- (2018) Calculate the binding energy per nucleon, in MeV and the packing fraction of an alpha particle.

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- (2018) Calculate the binding energy per nucleon, in MeV and the packing fraction of an alpha particle.
  - Given: Mass of proton = 1.0080 u, Mass of neutron = 1.0087 u and Mass of alpha particle = 4.0026 u.
- (2019) What is meant by the following terms as used in nuclear Physics?
  - Mass defect
  - Binding energy.
- (2019) Elaborate two aspects on which fission reactions differs from fusion reactions.
- (2019) Why is high temperature required to cause nuclear fusion?