	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**Department: SCIENCE 2021 – 22** **SUBJECT : PHYSICS**	**Date of submission:** **27. 02.2022**
Worksheet No:13 **WITH ANSWERS**	**Topic: NUCLEI**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT-	**CLASS & SECTION**	**ROLL NO.**

Two marks type questions:

1	Write any two characteristic properties of nuclear force. Answer: a. Nuclear forces are strongest forces in nature. b. Nuclear forces are charge independent.
2	Two nuclei have mass numbers in the ratio 1: 8. What is the ratio of their nuclear radii? Since $R = R_0 A^{1/3}$ $\Rightarrow R_1 : R_2 = (1^{1/3} : 8^{1/3}) = \left(\frac{1}{8}\right)^{1/3} = \mathbf{1 : 2}$
3	A nucleus ${}_Z X^A$ has mass represented by $M(A, Z)$. If M_p and M_n denote the mass of proton and neutron respectively and B.E., the binding energy in MeV, then Ans. $B.E. = [Z M_p + (A - Z) M_n - M(A, Z)] c^2$
4	**Two nuclei have mass numbers in the ratio 2 : 5. What is the ratio of their nuclear densities ?** **Ans.** The ratio of their nuclear densities is 1, as nuclear density is constant for all nuclei.

5	What is the nuclear radius of Fe^{125}, if that of Al^{27} is 3·6 fermi. **Ans.** As $\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{125}{27}\right)^{1/3} = \frac{5}{3}$. $R_1 = \frac{5}{3} R_2 = \frac{5}{3} \times 3{\cdot}6 = 6{\cdot}0$ fermi
6	**What is the effect on neutron to proton ratio in a nucleus when (*i*) an electron, (*ii*) a positron is emitted ?** **Ans.** In emission of an electron, a neutron is converted into a proton. Therefore, number of neutrons decreases and the number of protons increases. The neutron to proton ratio decreases. In the emission of a positron, a proton is converted into a neutron. Hence the ratio increases.
7	**Why heavy stable nucleus must contain more neutrons than protons ?** **Ans.** Coulomb forces between protons are repulsive and nuclear forces are ordinarily attractive. For nuclei to be stable nuclear forces must dominate the repulsive forces. Therefore, number of neutrons must be greater than the number of protons.

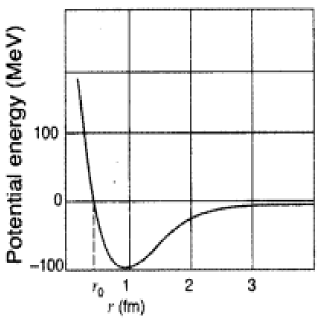
Fill in the blanks:

1. The energy equivalent of 1 amu is............... .
2. One electron volt is the...............when accelerated through a............... .
3. Density of nuclear matter is the...............mass of...............and its............... .
4. Isotopes of an element are the atoms...............which have...............but...............
5. Isobars are atoms of...............which have same...............but different...............
6. Isotones are the nuclides which contain............... .

1. 931 MeV
2. energy acquired by an electron; potential difference of 1 V.
3.ratio of; nucleus; volume
4.of an element; same atomic number; different atomic weights.
5. different elements; atomic weight; atomic numbers.
6. same number of neutrons.

Three marks type questions:

1	An electron and alpha particle have the same de-Broglie wavelength associated with them. How are their kinetic energies related to each other? Answer: $E_K = \frac{p^2}{2m}$ where E_K = Kinetic energy, p = momentum, m = mass of the particle de-Broglie wavelength, $\lambda = \frac{h}{p}$ ...where [h = Planck's constant $\therefore \lambda = \frac{h}{\sqrt{2mE_K}}$ $\because$ Both the particles have the same de-Broglie wavelength ...[Given $\therefore \frac{h}{\sqrt{2m_e E_{Ke}}} = \frac{h}{\sqrt{2m_\alpha E_{K\alpha}}}$ or $\frac{m_e}{m_\alpha} = \frac{E_{K\alpha}}{E_{Ke}}$ where m_e = mass of electron, m_α = mass of alpha particle, E_{Ke} = K.E. of electron, $E_{K\alpha}$ = K.E. of α-particle As $m_\alpha > m_e$ $\therefore$ K.$E_{Ke} > E_{K\alpha}$
2	Two nuclei have mass numbers in the ratio 1: 2. What is the ratio of their nuclear densities? Nuclear density, $f = \frac{\text{Mass of Nucleus}}{\text{Volume of Nucleus}}$ But, $R = R_0A^{1/3}$ $\therefore f = \frac{mA}{\frac{4}{3}\pi R_0{}^3 A}$ ...where [m is mass of proton or neutron and A is number of nucleons $\therefore f = \frac{m}{\frac{4}{3}\pi R_0{}^3}$ Thus, f is independent of A (mass number) $\therefore$ The ratio of density will be **1 : 1**.
3	Two nuclei have mass numbers in the ratio 8:125. What is the ratio of their nuclear radii?

	Answer: $A_1 : A_2 = 8 : 125 \Rightarrow \frac{A_1}{A_2} = \frac{8}{125}$ Since $R = R_0 A^{1/3}$ $\therefore$ $\frac{R_1}{R_2} = \frac{A_1^{1/3}}{A_2^{1/3}} = \frac{8^{1/3}}{125^{1/3}} = \frac{\mathbf{2}}{\mathbf{5}}$
4	A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6 MeV is split into two fragments Y and Z of mass numbers 110 and 130. The binding energy of nucleons in Y and Z is 8.5 MeV per nucleon. Calculate the energy Q released per fission in MeV. Answer: **Given :** $^{240}X = {}^{110}Y + {}^{130}Z$ $\therefore$ Gain in binding energy for nucleon = 8.5 − 7.6 = 0.9 MeV Hence total gain in binding energy per nucleus fission = 240 × 0.9 = 216 MeV
5	Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions which you can draw regarding the nature of nuclear forces. Answer: Two important conclusions : (i) Nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femtometres. This explains constancy of the binding energy per nucleon for large-size nucleus.  (ii) Graph explains that force is attractive for distances larger than 0.8 fin and repulsive for distances less than 0.8 fm.

6	**A nucleus with mass number A = 240 and $\frac{BE}{A}$ = 7.6 MeV breaks into two fragments each of A = 120 with $\frac{BE}{A}$ = 8.5 MeV. Calculate the released energy.** Binding energy of nucleus with mass number 240, $(E_{BN})_1 = 240 \times 7.6$ MeV ...(*i*) Binding energy of two fragments $(E_{BN})_2 = 2 \times 120 \times 8.5$ MeV ...(*ii*) Energy released $= (E_{BN})_2 - (E_{BN})_1$ $= (2 \times 120 \times 8.5) - (240 \times 7.6)$ $= 240(8.5 - 7.6) = 240 \times 0.9$ $= 216$ MeV
7	Calculate the energy in fusion reaction : $^2_1H + ^2_1H \longrightarrow ^3_2He + n$, **where BE of ^2_1H = 2.23 MeV and of ^3_2He = 7.73 MeV** Answer: Total binding energy of initial system (E_i) $= ^2_1H + ^2_1H = (2.23 + 2.23)$ MeV = 4.46 MeV Binding energy of final system *i.e.* $^3_2He\,(E_f) = 7.73$ MeV Hence, energy released $= E_f - E_i$ $= 7.73$ MeV $- 4.46$ MeV **= 3.27 MeV**

PREPARED BY: MS. ANU ANNIE MATHEWS	CHECKED BY: HOD - SCIENCE