Structure of The Nucleus Assignment

1. Complete the following table of isotopes (replace the x symbols with the correct numbers):

Element symbol	Number of protons	Number of neutrons	Mass number	Atomic number
$_{x}^{x}\text{C}$		6		6
$_{10}^{x}\text{Ne}$			20	
$_{20}^{42}\text{Ca}$				
$_{x}^{x}\text{Al}$		14	27	
$_{x}^{216}\text{Po}$	84			

/5

2. Explain how it is possible to have stable nuclei despite the strong repulsive electrostatic force between the protons. /1

3.
    a) Describe what an isotope of an element is. /1

    b) Explain why the isotopes of a given element are chemically identical. /2
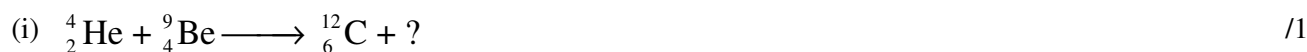
4.
    a) A nitrogen-14 nucleus has a mass of 2.32×10^{-26} kg. If it forms from 7 protons and 7 neutrons, calculate the mass defect and binding energy (in J and MeV). /3

    b) State whether energy was released or absorbed during the reaction in part a. /1

5.
    a) Complete the following nuclear reaction equations:

    (i) $_{2}^{4}\text{He} + _{4}^{9}\text{Be} \longrightarrow _{6}^{12}\text{C} + ?$ /1

    (ii) $_{13}^{27}\text{Al} + _{0}^{1}\text{n} \longrightarrow _{1}^{1}\text{H} + ?$ /1

    (iii) $_{94}^{241}\text{Pu} + ? \longrightarrow _{94}^{242}\text{Pu} + \text{energy}$ /1

    (iv) $_{88}^{226}\text{Ra} \longrightarrow _{86}^{222}\text{Rn} + ?$ /1

    b) When a nucleus of iron-56 forms, a photon of energy 504 MeV is emitted. Calculate the difference in mass between the reactants and the products. /2

6.
    a) A uranium-238 nucleus can decay spontaneously: $_{92}^{238}\text{U} \longrightarrow _{2}^{4}\text{He} + _{90}^{234}\text{Th}$

    Using the law of conservation of momentum, show that the ratio of the speed of the helium nuclei to that of the thorium nuclei is approximately 58.5. Assume that all the nuclei start at rest. /3

    b) Explain, using the law of conservation of momentum, why a particle of relatively small mass that is emitted by a nucleus acquires most of the kinetic energy released in the reaction. /2

7.
    a) Describe with the aid of a nuclear reaction equation how each of the following medical radioisotopes may be produced:
    (i) phosphorus-32 /2
    (ii) fluorine-18 /2
    (iii) oxygen-15 /2

    b) Identify one use of the radioisotope phosphorus-32. /1

TOTAL   /31