11 PHYSICS ATAR
ASSIGNMENT 7: NUCLEAR PHYSICS

NAME: _____ **DUE DATE:** _____ **TOTAL:** ___/52

1. Complete the following table.

ELEMENT	NUMBER OF PROTONS	NUMBER OF NEUTRONS	NUMBER OF ELECTRONS
$^{87}_{37}Rb$			
$^{148}_{62}Sm$			
$^{187}_{75}Re$			

(3)

2. Explain the following characteristics and behaviours of the different radiations.

(a) α particles are stopped by tissue paper but β particles are not.

(1)

(b) β particles are electrons that originate from the nucleus.

(1)

(c) γ rays have no charge or mass.

(1)

(d) α particles have a much larger quality factor than either β particles or γ rays.

(1)

(e) α particles are dangerous if in contact with the skin but are far more dangerous if inhaled.

(1)

3. (a) Background radiation constantly exists around us. Describe ***two sources*** of this radiation.

(i)

(ii)

(2)

(b) Some communities of people live at high altitudes in various countries. Are they exposed to more or less background radiation? Explain your answer.

(2)

4. Complete the following nuclear equations.

(a) $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + \_\_\_\_\_$

(b) $^{9}_{4}Be + \_\_\_\_\_ \rightarrow ^{12}_{6}C + ^{1}_{0}n$

(c) $^{27}_{13}Al + ^{4}_{2}He \rightarrow \_\_\_\_\_ + ^{0}_{0}\gamma$ (3)

5. When Lithium-7 is bombarded with protons, two α particles are produced. The disintegration is represented by the following equation.

$$^{7}_{3}\text{Li} + {}^{1}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + {}^{4}_{2}\text{He}$$

Calculate the E_k possessed by the α particles.

(Masses: $^{7}_{3}$Li - 7.01818 u proton - 1.00813 u $^{4}_{2}$He - 4.00389 u)

(4)

6. During a controlled experiment, a researcher measured the radioactivity levels of a sample as 4.25×10^3 counts/minute. The half-life had previously been determined as 4.70 minutes.

(a) What radiation level would be measured after 21.0 minutes?

(3)

(b) If the sample had an initial mass of 38.0 g and decayed by emitting α particles, about how much mass would be left after 23 minutes? Explain your answer.
(**No calculations are necessary**.)

(2)

7. Calculate the binding energy per nucleon in MeV for $^{32}_{16}S$ atoms, given the mass of an atom is 32.00122 u.

(5)

8. A 70.0 kg worker in the food-irradiation industry is exposed to a total of 14.7 J of energy due to slow neutron radiation. Calculate:

(a) the absorbed dose of the worker.

(2)

(b) the dose equivalent in Sieverts.

(2)

9. Nuclear fission is used to produce about 17 % of the world's electrical energy. With increasing concern for global warming and the impact of increasing CO_2 levels from burning fossil fuels, greater attention is being paid to using nuclear power as a "clean alternative".

(a) Explain the role of the following in a fission reactor, giving an example of a suitable material for each role.

(i) moderator

(ii) control rod

(iii) coolant

(6)

(b) (i) What is a ***breeder reactor***?

(2)

(ii) Why does this type of reactor not require a moderator?

(1)

(c) Describe ***two disadvantages*** that nuclear power stations have over conventional power stations.

(i)

(ii)

(2)

10. (a) What is meant by the term ***critical mass***?

(2)

(b) Explain how this term relates to the development of atomic weapons during the 1940's and 1950's?

(2)

11. Nuclear fusion is a process for producing energy that is seen in stars, producing successively heavier elements as the process continues. Scientists have had limited success on Earth in developing the fusion process.

(a) Describe ***one significant advantage*** that fusion power would have over fission-based processes.

(1)

(b) As heavier nuclei are produced within a star, what must be true about the successive binding energies of the elements as the fusion process continues?

(1)

(c) Which nuclide represents the "end product" of such reactions?

(1)

(d) Why is it necessary to have temperatures of a least 1.0×10^6 °C to initiate a fusion reaction?

(1)