UTHM
Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2021/2022

| | | |
|---|---|---|
| COURSE NAME | : | ATOMIC AND NUCLEAR PHYSICS |
| COURSE CODE | : | BWC 20903 |
| PROGRAMME CODE | : | BWC |
| EXAMINATION DATE | : | JANUARY / FEBRUARY 2022 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | 1. ANSWER **ALL** QUESTIONS.<br>2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSED BOOK**. |



THIS QUESTION PAPER CONSISTS OF **FOUR** (4) PAGES

Q1 (a) Various elements of electron transition processes will provide different results. Explain the possible properties of an electron if it is subjected to the

(i) X-ray process.

(5 marks)

(ii) Auger effect.

(5 marks)

(b) Calculate the mass defect and binding energy per nucleon for each of the following nuclides.

(i) Oxygen -16 (atomic mass = 15.994915 amu).
(ii) Nickel-58 (atomic mass = 57.935346 amu).
(iii) Xenon-129 (atomic mass = 128.904780).

(6 marks)

(c) The mass of Cobalt-59 is 58.933198 amu. Find the nuclear binding energy of Cobalt-59 in MeV. Given the mass of Hydrogen-1 is 1.00783 amu.

(4 marks)

Q2 (a) Isotope Iodine-131 has been used in radioactive Iodine therapy to treat thyroid disease.

(i) Describe the isotope's properties that make it ideal for this technique.

(4 marks)

(ii) Determine the safety precautions that medical physicists must take when administering this therapy.

(5 marks)

(iii) If the patient is pregnant, is it feasible that the therapy will be continued? Justify your answer.

(5 marks)

(b) Strong nuclear forces have a large impact on nuclear reactions. Explain how the pion, kaon, and neutron play a part in this process.

(6 marks)

Q3 (a) Cesium-137 which has half-life of 30.2 years is a component of the radioactive waste from nuclear power plants. Calculate the age of a radioactive waste sample if the activity due to cesium-137 has reduced to 35.2 percent of its starting value.

(3 marks)

(b) Write the balanced equations for the following nuclear reactions.

(i) Nuclide carbon-14 undergoes beta decay.
(ii) Thorium-232 decays by alpha particle emission.
(iii) Nitrogen-13 decays by positron emission.
(iv) Cobalt-60 decays by gamma radiation.
(v) Tungsten-181 decays by electron capture.

(10 marks)

(c) (i) With a half-life of 10 minutes, Nitrogen-13 decays to Carbon-13. Assume you are starting with a quantity of 2 g of Nitrogen-13. Determine how many grams of Nitrogen-13 will be left after 42.7 minutes.

(4 marks)

(ii) The half-life of Maganese-56 is 2.6 hours. Calculate how much Manganese-56 will remain after 24.3 hours if the initial sample is 10 g.

(3 marks)

Q4 (a) After two years, the weight of 1 g of Strontium-90 will be 0.953 g. Find

(i) the half-life of Strontium-90.

(3 marks)

(ii) how much Strontium-90 will remain after 5 years.

(3 marks)

(iii) the initial activity of the sample in Bq and Ci.

(3 marks)

(b) The atomic ratio Carbon-14/Carbon-12 of charcoal found in a deep layer of silt in a cave is only 30%. Charcoal has a known age of 1850 years. Calculate the deeper layer's age.

(5 marks)

(c) Technicium-99m ($^{99m}$Tc) is used for nuclear medicine imaging procedures. The minimum dose that generates a useful image is 5 mCi. At 12 p.m. on Friday, Sept. 22, a radioisotope generator is calibrated to contain 500 mCi of $^{99}$Mo. The generator will then be eluted on Wednesday, September 27 at 8 a.m. Is there enough $^{99m}$Tc for ten patient imaging studies?. Show your calculations.

(6 marks)

Q5 (a) Uranium are the most widely utilised elements in nuclear power reactors for fission processes.

(i) In your opinion, if elements other than uranium are employed in nuclear fission processes, is it conceivable?.

(5 marks)

(ii) Describe your answer in **Q5(a)(i)** with evidence from previous research.

(5 marks)

(b) The Malaysian government introduced nuclear power as one of its energy options to fulfill its electrical power demand after 2020. Describe the availability and readiness of Malaysia to meet this goal.

(5 marks)

(c) If you are a nuclear engineer, explain the critical criteria that must be met in order to improve the quality of existing nuclear power plants.

(5 marks)

-END OF QUESTIONS -