QA-5329

M. Sc. (Sem. III) Examination, Dec.-2023

PHYSICS

PAPER - 3.1

PHY-301 : Nuclear Physics-I

Time Allowed : **Three Hours**

Maximum Marks : **70**
Min. Pass Marks : **28**

Note : *This question paper will be divided into three sections as under :*

SECTION - A **Max. Marks 10**

This section shall have 01 compulsory question comprising 10 questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark and total marks of this section will be 10. This section will be compulsory in the paper.

SECTION - B **Max. Marks 25**

This section will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Students are instructed to attempt five questions by selecting one question from each unit.

SECTION - C **Max. Marks 35**

Will carry 35 marks with five long answer type questions comprising one complusory question (question no. 07) of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 50 words) and any two more questions (answer about in 400 words) out of remaining four questions.

SECTION - A

1×10=10

1 (i) Why binding energy per nuclear curve is so important to explain the nuclear stability ?

(ii) What do you mean by the saturation nature of the nuclear force ?

(iii) Write the general form of two nuclear interaction potential (AV8).

(iv) What is meant by the velocity dependent potential ?

(v) What do you understand by the coherent and incoherent scattering lengths ?

(vi) Is it possible that the nuclear forces are repulsive at short distance ? (r~0.2F)

(vii) What are the dimensions of the linear and mars attenuation coefficients ?

(viii) What is the physical importance of the Bragg curve ?

(ix) What do you mean by the quenching in case of gas filled counters ?

(x) Is it possible to accelerate the electron using cyclotron upto high energy ?

SECTION - B

UNIT - I

2 What do you understand by the Binding energy per nuclear (B/A) ? The B/A decreases with A for heavy nuclei. What may be the possible reason for the decrease?

5

OR

A 5 meV α-particle is projected on a $^{208}_{82}Pb$ nucleus calculate the distance of closest approach of the α- particle to the target nucleus. Compare it with the radius of the nucleus.

5

UNIT - II

3 Show that there is no existance of the $_1H^2$ excited state for $n>0$ and $l>0$.

5

OR

Describe the ground state properties of the $_1H^2$ system.

5

UNIT - III

4 What do you understand by the scattering length ? Discuss its physical importance. 5

OR

Find the total cross section for *n-p* scattering for *n* energy 2 *MeV* in *L* system. Given

$a_t = 5.38\ fm$

$a_s = -23.7\ fm$

$r_{os} = 2.4\ fm$

$r_{ot} = 1.07\ fm$ 5

UNIT - IV

5 Prove that the photoelectric effect cannot take place with a free electron. 5

OR

Bring out the main differences in the energy lost by a photon, proton and electron, each of 1 *MeV* energy when they pass through the same absorber material. 5

UNIT - V

6 Discuss the construction and working of GM counter. Also, describe its applications. 5

OR

In a proton synchrotron the guiding magnetic field is 1.8 w/m^2. Find the radius required to obtain the proton energy of 10 *GeV*. 5

SECTION - C

7 Match the List I with List II.

	List I (Nuclei)	List II (nuclei example)
(1)	Isotopes	$^{14}_{7}N$, $^{14}_{6}C$
(2)	Isobars	$^{137}_{56}Ba$, $^{137}_{56}Ba^*$
(3)	Isotones	$^{14}_{7}N$, $^{15}_{7}N$
(4)	Mirrors	$^{13}_{6}C$, $^{13}_{7}N$
(5)	Isomers	$^{13}_{6}C$, $^{14}_{7}N$

15

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8 Solve the schrodinger equation for the deuteron system and find the range depth relationship as

$$K_1^h \cot K_1 h = -\alpha h$$

Where $K_1^2 = \frac{M}{h^2}(V_o - E_d)$

$$\alpha^2 = \frac{M}{h^2} E_d .$$

Also, show the wave function of the ground state of the deuteron system.

10

9 What are the essential differences between *n-p* and *p-p* scattering at low energies. Discuss the theory of low energy *p-p* scattring.

5+5=10

10 Discuss the energy lost by the light charge particle such as e^-, e^+ passing through the medium. In what respect, the interaction is differ from the heavy charge particles (α, p).

10

11 With the help of block diagram explain the working of a *NaI* (*Tl*) scintillation spectrometer. What is the purpose of Tl activation in the crystal ? Also draw the spectrum of 662 KeV γ-rays of ^{137}Cs source taken from this spectrometer.

5+2+3=10.