PHE-11

ASSIGNMENT BOOKLET
Bachelor's Degree Programme (B.Sc.)

MODERN PHYSICS

Valid from January 1, 2020 to December 31, 2020

It is compulsory to submit the Assignment before filling in the Term-End Examination Form.

Please Note

- **You can take electives (56 or 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.**
- **You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.**
- **At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits out of those 64 credits should be from lab courses.**
- **You cannot appear in the Term-End Examination of any course without registering for the course. Otherwise, your result will not be declared and the responsibility will be yours.**

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068

2020

Dear Student,

We hope you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the section on assignments in the Programme Guide for Elective Courses that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, which would consist of **one tutor-marked** assignment for this course.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully:

1) On top of the first page of your TMA answer sheet, please write the details exactly in the following format:

ENROLMENT NO. : ……

NAME : ……

ADDRESS : ……

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COURSE CODE : ……..

COURSE TITLE : ……..…….

ASSIGNMENT NO. : ……..…

STUDY CENTRE : ……..……. DATE : ….……...……

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise.

5) While solving problems, clearly indicate the question number along with the part being solved. Be precise. Write units at each step of your calculations as done in the text because marks will be deducted for such mistakes. Take care of significant digits in your work. Recheck your work before submitting it.

6) **This assignment will remain valid from January 1, 2020 to December 31, 2020**. However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool.

We strongly feel that you should retain a copy of your assignment response to avoid any unforeseen situation and append, if possible, a photocopy of this booklet with your response.

We wish you good luck.

Tutor Marked Assignment
MODERN PHYSICS

Course Code: PHE-11
Assignment Code: PHE-11/TMA/2020
Max. Marks: 100

Note: Attempt all questions. Symbols have their usual meanings. The marks for each question are indicated against it.

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1. a) Inside a spacecraft travelling at a speed of $0.8c$ with respect to the earth, the time interval between two events on the earth is measured to be 30 hrs. What would the time interval be if the spacecraft was travelling at a speed of $0.9c$. (5)

   b) Two rockets of rest length L approach each other with equal speeds of $0.4c$. How long would one rocket appear to the other? (5)

   c) A rocket is launched from a spaceship travelling with a speed of $0.8c$ towards the earth. If the speed of the rocket is $0.6c$, what would be its speed as observed by an observer on earth if the rocket is moving

   (i) towards the earth (ii) away from the earth? (5)

   d) The frequency of the light emitted by a galaxy receding from the earth is measured to be 1.5×10^3 MHz. Assuming that the wavelength of the light source is 22.5 cm, calculate how fast the galaxy is receding from the earth? (5)

   e) A particle of mass M, initially at rest, decays into two particles with rest masses m_1 and m_2 respectively. Show that the total energy of the mass m_1 is:

$$E_1 = \frac{c^2[M^2 + m_1^2 - m_2^2]}{2M}$$ (5)

2. a) The transition rate of electrons from the first excited state of the hydrogen atom to the ground state is $\sim10^8$/s. What is the minimum range of energies of the resulting photons that are emitted? (5)

   b) A photon and an electron each have an energy of 6.0×10^3 eV. What are their wavelengths? Which of these would you use to probe atomic structures? (5)

   c) Show that

$$\left[x,\ e^{\frac{iap}{\hbar}}\right] = -ae^{\frac{iap}{\hbar}}$$ (5)

   d) An electron has the following wave function:

$$\psi(x) = Ae^{-x}(1-e^{-x}),$$

   Determine

   i) the normalization constant A, and

   ii) the expectation value of x. (5+5)

3. a) Obtain an expression of probability for finding the free particle at position x confined in a box of length a. (5)

   b) Using Moseley's law, obtain the frequency of an X-ray line when L to K transition takes place in silver atom. It is given that $\sigma = 3$. (5)

   c) Consider a proton as a bound oscillator with a natural frequency of 4×10^{21} Hz. Calculate the energy of its ground and first excited states. (5)

   d) Obtain the most probable value and expectation value of r for the ground state of a hydrogen atom. (5)

   e) State Hund's rules. Obtain the ground state terms of Li and Si. (5)

4. a) The half-life of cobalt-60 is 5.274 years. Calculate the activity of a sample of cobalt-60 weighing 1 μg in units of Curie (Ci). (5)

   b) Write an expression for semi-empirical formula for binding energy of nuclei given by Weizsacker and discuss its each term. Using this formula, calculate the binding energy per nucleon for ^{235}U. (5)

   c) With the help of a schematic diagram, describe the shell model of nuclei. (5)

   d) Define multiplication factor. When is a reactor said to be supercritical, critical and subcritical? Write the importance of multiplication factor in a nuclear reactor. (5)

   e) Identify whether the following particles are baryons, leptons or mesons. Write the observable properties of these particles.

   Σ^+, Λ, Π°, η°, μ (5)

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