

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-IV Internal Examination, 2024

Paper – PHSACOR09T

Elements of Modern Physics

Time: 1 Hour

Full Marks: 20

1. Answer any five questions from the following:

2×5=10

- (a) Write down the important characteristics of nuclear force.
- (b) Why do not we observe a Compton effect with visible light?
- (c) Show that in Compton scattering, while the photon can be scattered at any angle between 0° to 180° , the recoil electron can only be emitted at angles between 0° to 90° .
- (d) Find out the relation between the mean life time and half life time of a radioactive decay.
- (e) Assuming spherical shape of atomic nucleus, show that density of nuclear matter is constant.
- (f) Calculate the binding energy and packing fraction for helium. The atomic masses of proton, neutron and helium are 1.00814 u, 1.00898 u and 4.00387 u respectively. [1u = 931.5 MeV]
- (g) What do you mean by ultraviolet catastrophe?

2. Answer any two questions from the following:

5×2=10

- (a) Draw schematically the nuclear binding energy curve. Hence explain nuclear fission and fusion. 2+3
- (b) Deduce Planck's radiation formula. Show that in the limits of very long and very short wavelengths, Planck's formula reduces to Rayleigh-Jeans formula and Wien's formula respectively. 2+3
- (c) Discuss the de Broglie's hypothesis regarding matter waves. Show that electrons cannot exist within the nucleus. 2+3
- (d) What is Einstein's light quantum hypothesis? Write down Einstein's photoelectric equation. Discuss how the new theory proposed by Einstein explains the essential features of photoelectric emission? 1+1+3

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1. Answer any five questions from the following:

2×5=10

- (a) What is 'ultraviolet catastrophe'?
- (b) Show that electron can not exist within nucleus.
- (c) Define binding energy of nucleus.
- (d) What is population inversion ?
- (e) Assuming spherical shape of Atomic nucleus, show that nuclear mass density is independent of mass number.
- (f) Write down the important characteristics of nuclear force.
- (g) Why we do not observe Compton effect with visible light?
- (h) Show that photoelectric effect can not take place with a free electron.

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2. Answer any two questions from the following:

5×2=10

- (a) Deduce Planck's law of blackbody radiation. Derive Rayleigh-Jeans' law from Plank's law of blackbody radiation. 4+1
- (b) What are Einstein's A, B Coefficients? Derive a relation between them. 2+3
- (c) Show that change of wavelength in Compton scattering is independent of the incident wavelength. At what scattering angle is the Compton shift is equal to the Compton wavelength? 4+1
- (d) Sketch schematically the N-Z plot where N is the neutron number and Z is the atomic number. Briefly explain the significance of the plot. Find out the the relation between the mean life time and half life time of a radioactive decay. 1+2+2

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