

5m/PHY-302 Syllabus-2023

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(Nov-Dec)

FYUP : 5th Semester Examination

MINOR

PHYSICS

(Modern Physics—I)

PHY-302

Marks : 75

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer any **ten** questions

1. (a) Discuss briefly about the photoelectric effect and Compton effect. 2½+2½=5
(b) Let E_1 , E_2 , E_3 and E_4 represent the energies of a photon associated with ultraviolet, X-ray, infrared and visible light. Arrange the given energies in increasing order and justify your answer. 2½
2. (a) State the de Broglie hypothesis of matter wave. 3

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(Turn Over)

(2)

- (b) Let λ_1 and λ_2 represent the de Broglie wavelengths of two moving particles of masses M and $4M$ with same kinetic energy. If $\lambda_1 = 1 \text{ \AA}$, then find the value of λ_2 . 4½
3. (a) Consider a car (mass = 1000 kg) and an electron (mass = $9.1 \times 10^{-31} \text{ kg}$) each moving with the same speed of 40 m/sec. If there is 1% uncertainty in measurement of their momentum, then find the uncertainty in their positions. Give that the value of Planck constant (h) is $6.63 \times 10^{-34} \text{ Joule sec.}$ 2+2=4
- (b) Calculate the minimum uncertainty in the energy of the excited state of an atom if the lifetime of the excited state is about 10^{-8} sec. 3½
4. (a) Discuss the key differences between crystalline and amorphous solids. Give one example of each. 3½+1=4½
- (b) Define the electrical conductivity and specify its units. Discuss the classification of solids based on their electrical conductivities. 1+2=3
5. (a) Using the band theory, explain why metals are good conductor whereas insulators are bad conductor of electricity. 4

(3)

- (b) Explain the temperature dependent variation of the electrical conductivity of an intrinsic semiconductor. Plot the qualitative graph between conductivity and temperature. $2\frac{1}{2}+1=3\frac{1}{2}$
6. (a) Discuss the mechanism of heat transfer in solid. Explain why metals are better conductor of heat than insulators. $2+2=4$
- (b) Define thermal conductivity and give its unit. Explain why we feel cold when we touch a metal in winter. $1+\frac{1}{2}+2=3\frac{1}{2}$
7. (a) Define the following terms and give their units : $1\frac{1}{2}+3=4\frac{1}{2}$
- (i) Magnetic susceptibility
 - (ii) Magnetization
 - (iii) Magnetic flux
- (b) A paramagnetic material of magnetic susceptibility (χ), 2×10^{-5} is placed in a magnetic field $0.1 \times 10^{-4} \text{ Am}^{-1}$. Calculate the magnetization of the material. 3
8. (a) Discuss briefly about the ferromagnetic, antiferromagnetic and ferrimagnetic materials. $4\frac{1}{2}$
- (b) Discuss the Bloch $T^{3/2}$ law and Curie-Weiss law for ferromagnetic materials. $1\frac{1}{2}+1\frac{1}{2}=3$

(4)

9. (a) Describe the characteristic properties of superconductors. Write their three applications. $3+1\frac{1}{2}=4\frac{1}{2}$

(b) Discuss briefly the key differences between type-I and type-II superconductors. Give one example of each. $2+\frac{1}{2}+\frac{1}{2}=3$

10. (a) Explain qualitatively the origin of magnetic moment in an atom. Out of H, He, Na, Ne, Ar and Fe, identify the atom(s) with non-zero magnetic moment with proper explanations. $2+2\frac{1}{2}=4\frac{1}{2}$

(b) Using the Bohr model, find the energy required to excite the hydrogen atom from its ground state to second excited state. 3

11. (a) Discuss the characteristic properties of light emitted by the LASER. $5\frac{1}{2}$

(b) Describe briefly the difference between spontaneous and stimulated emission of radiation. 2

12. (a) Discuss the conditions for LASER action. $3\frac{1}{2}$

(b) State and explain the Pauli exclusion principle. Obtain the net spin of helium and lithium atoms in their ground state. $2+1+1=4$

(5)

13. (a) Describe the liquid-drop model of nucleus. $4\frac{1}{2}$
- (b) Let R_1 and R_2 represent the radii of two different nuclei with $A = 27$, $Z = 12$ and $A = 64$, $Z = 29$ respectively. Find the value of $\frac{R_1}{R_2}$. 3
14. (a) What is binding energy? Calculate the binding energy of an alpha particle both in MeV and in joule. Given that—
- (i) 1 a.m.u. = 931 MeV;
- (ii) masses (in a.m.u.) of α -particle, proton and neutron are 4.001506, 1.007825 and 1.008665, respectively. $1+3=4$
- (b) What is radioactivity? Describe the different types of radioactive decay. $\frac{1}{2}+3=3\frac{1}{2}$
15. (a) Discuss the difference between nuclear fission and nuclear fusion. Give one example of each. $1+1+1=3$
- (b) Describe the construction and working principle of a nuclear reactor. $2+2\frac{1}{2}=4\frac{1}{2}$

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