

Total Marks: 20, All questions compulsory

1. What group is obtained by adding to or deleting from each of the following groups the indicated symmetry operation? (4)
 - (a) C_3 plus i
 - (b) S_4 plus i
 - (c) C_3 plus S_6
 - (d) S_6 minus i
2. Write down all the operations of a D_{nh} group. What is the order of a D_{nh} group? (2)
3. Which of the following pair of operations always commute? (2)
 - (a) Two proper rotations about different axes
 - (b) Two C_2 rotations about perpendicular axes
 - (c) Reflection through planes perpendicular to each other
4. If we start with the multiplication table for the group G_3 (A, B, E) and add another element C, what will be the order of the new group? Write the multiplication table of the new group assuming C commutes with A and B. (1+2)
5. Prove that for a cyclic group G_n , each element is a class in itself. (2)
6. Argue that absence of S_n is a necessary and sufficient condition for dissymmetry. (2)
7. Show that the expectation value of dipole moment for a superposition state, $\psi(t) = a_0\psi_0(t) + a_1\psi_1(t)$ is time-dependent, where ψ_0 and ψ_1 are solutions of the time-dependent Schrodinger equation. (3)
8. Calculate the time it takes for a 2-level system ($M_{10} = 3.313 \times 10^{-14}$ C m) to be completely inverted, when interacting with an intense radiation ($E_0 = 10^{-10}$ kg m C⁻¹ s⁻²) at resonance; Planck's constant, $h = 6.626 \times 10^{-34}$ m² kg s⁻¹. (2)

