Ph.D. ENTRANCE EXAMINATION, OCTOBER 2015

Section – B & C

Time : 140 Minutes   Max. Marks : 160

Instructions :

(This is to test the candidate's ability of defining concepts through short answers.)

1) Answer **any twelve** questions from Section **B** and **one** question from Section **C**.

2) In Section **B each** question carries **10** marks. Section **C** carries **40** marks.

3) In Section **B** an answer should not exceed **100** words. In Section **C** an answer should not exceed **500** words.

4) Candidates should **clearly** indicate the **Section, Question Number** and **Question Booklet code** in the answer paper.

5) The candidates are **permitted** to answer questions **only** from the subject that comes under the **faculty** in which he/she seeks registration as indicated in the **application** form.

FACULTY OF SCIENCE

1. **Physics**

2. **Chemistry**

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Name of Candidate

Register Number

Answer Booklet Code

Signature of Candidate

Signature of Invigilator

FACULTY OF SCIENCE

1. PHYSICS

Section – B

1. Obtain the eigen values for J^2, J_z, $J+$ and $J\_$ and for the matrices. What are Pauli spin matrices ?

2. Define Hermitial operators. Show that the eigen values of a Hermitian operator are real.

3. Obtain the relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.

4. a) Write the condition for a transformation to be Canonical.

   b) Derive equations of motion in Poisson Bracket form.

5. Evaluate the canonical partition function for a system of N independent harmonic oscillators. Obtain the Helmholtz free energy of the system.

6. Derive Lorentz transformation equations.

7. Write about gravitation and acceleration and their relation with Non-inertial frames of reference.

8. Explain free electron theory of metals.

9. Discuss briefly quantum theory of para magnetism.

10. What are gauge transformations ? Obtain Maxwell's equation for scalar and vector potentials in Lorentz gauge.

11. Explain the input and output characteristics of a CE, CB and CC configurations of transistor amplifier. What are hybrid parameters ?

12. What are the features of an ideal Operational Amplifier ? Draw the circuit of a differential amplifier with OPAMP and explain its working.

13. Discuss the quantum mechanical explanation for Raman Scattering. What is meant by Resonance Raman Scattering ?

14. What is population inversion ? Discuss different types of pumping in laser.

15. Explain Maxwell-Boltzmann Statistics.

16. Prove that Kronecker delta is a mixed tensor of rank 2 and that it is invariant.

10. Explain the general principles governing cycloaddition reactions.

11. What are Projection operators ? Construct the hybrid orbitals of the BF_3 molecule ? (Character table for the D_{3h} point group is given below)

D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$		
A_1'	1	1	1	1	1	1		x^2+y^2, z^2
A_2'	1	1	-1	1	1	-1	R_z	
E'	2	-1	0	2	-1	0	(x, y)	(x^2-y^2, xy)
A_1''	1	1	1	-1	-1	-1		
A_2''	1	1	-1	-1	-1	1	z	
E''	2	-1	0	-2	1	0	(R_x, R_y)	(xz, yz)

12. What is meant by Jahn-Teller distortion ? Explain its consequences with example.

13. Discuss the synthesis of quinine with details on the mechanism of the reactions involved.

14. One mole of steam at 100 °C is converted to ice at 0 °C. Calculate the entropy change associated with the process. The latent heat of fusion of ice and the latent heat of vaporization of ice are 80 cal/g and 540 cal/g, respectively.

15. Calculate the change in pH caused by dissolving 1.025 g of anhydrous sodium acetate in 100 cm^3 of 0.25 mole/dm^3 acetic acid. (Molecular weight of anhydrous sodium acetate = 82; pK_a of acetic acid = 4.74)

16. Why are nanoparticles of metals behave differently from the bulk metals ? Discuss the origin of the colour of metal nanoparticles.

Section – C

1. Discuss the crystal-field splitting in the octahedral, tetragonal, square planar, and the tetrahedral metal complexes with suitable examples.

2. Explain the quantum mechanical model of vibrational spectroscopy. Discuss how IR and Raman spectroscopic techniques differ and how they complement each other to elucidate molecular structure.

3. Discuss the principles of green chemistry. How does olefine metathesis falls in the category of green chemistry ?

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