Notice

Date: Thursday, 06/04/2023

It is hereby informed to the students of M.Sc. – I and II, that Second Term Internal Evaluation Examination is scheduled between 20th to 21st April 2023 in the Department of Physics.

Instructions:

1) Nature of question paper for M.Sc. – I: 05 MCQ's (05 Marks), 01 Short Answer Questions (05 Marks), 01 Long Answer Questions (10 Marks)
2) Nature of question paper for M.Sc. – II: 05 MCQ's (05 Marks), 01 Short Answer Questions (05 Marks), 01 Long Answer Questions (10 Marks)
3) Students should present before 15 minutes of the examination.
4) Answer sheets will be provided by the Department.
5) Strictly mention the Full Name and Roll number on Answer Sheet correctly.
6) All students should remain present for the Internal Examination as the examination will not be conducted afterwords in any case.

Sr. No.	Date	Class	Name of the Paper	Time
01	20/04/2023	M. Sc. – I	Quantum mechanics- II	11 – 12 AM
			Statistical mechanics	12 – 01 PM
02	20/04/2023	M. Sc. – II	Experimental techniques	11 – 12 AM
			Electronic devices and applications	12 – 01 PM
03	21/04/2023	M. Sc. – I	Electrodynamics	11 – 12 AM
			Atomic and Molecular Physics	12 – 01 PM
04	21/04/2023	M. Sc. – II	Solid State Physics- III	11 – 12 AM
			Solid State Physics- IV	12 – 01 PM

Coordinator

HOD, Physics
Head of the
Department of Physics
Vivekanand College, Kolhapur

VIVEKANAND COLLEGE ESTD JUNE 1964 KOLHAPUR - 416003

"Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Autonomous)

Department of Physics

M.Sc. Part-I SEM II Internal Examination (2022-23)

Quantum Mechanics II

Time :- 3.00 pm-4.00 pm Total Marks: 20

Instructions:-

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q.1. Choose correct alternative **(5)**

1. In case of Born approximation validity condition is…….
   a) $|\Psi sc| \gg 1$ b) $|\Psi sc| \ll 1$ c) $|\Psi sc| \neq 1$ d) $|\Psi sc| = 1$
2. For resonance scattering K_1a must be …… multiple of scattering cross section
   a)even b) irrational c) odd d) rational
3. According to Optical theorem total scattering cross section is …… times the imaginary part of scattering amplitude
   a) $\frac{4\pi}{k}$ b) $4\pi k$
   c) $\frac{4k}{\pi}$ d) $\frac{\pi}{4k}$
4. In case of scattering of identical particles the value of quantum scattering cross section is……. the classical scattering cross section
   a) half b) thrice c) same d) double
5. The relation between scattering cross amplitude and cross section is
   a) $\sigma = |f(\theta)|$ b) $\sigma^2 = |f(\theta)|$ c) $\sigma = |f(\theta)|^2$ d) $\sigma = \frac{1}{|f(\theta)|}$

Q.2 Attempt any one **(10)**

1. Explain born approximation and its validity condition.
2. With a free particle solution explain partial wave expansion of plane wave into spherical wave.

Q.3 Attempt any one. **(05)**

1. Explain resonance scattering for low energy case.
2. Write a note on Eikonal equation.

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Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College (Autonomous) Kolhapur

Department of Physics

M.Sc. I Internal Examination, April-2023

Attendance Sheet

Date: **Quantum Mechanics-II**

Roll. No.	Name of Candidate	Sign
1331	Ahiwale Snehal Nitin	
1332	Biradar Anand Nagappa	
1333	Jarkoli Smith Kallappa	
1334	Kavatagi Shivraj C.	
1335	Mithari Shweta Sardar	
1336	Randive Rajshree Mahesh	
1337	Sagar Shivani Dattatryay	
1338	Chuhan Aditi S.	
1339	Shirke Pranali Pradip	
1340	Shirodkar Shubham R.	
1341	Todkar Dnyaneshwari Pandit	

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

।। ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।।
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34441
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT 20/20

Signature of Supervisor

Suppliment No. : Internal Exam 2022-23

Roll No. :

Class : 1342

Subject : Quantum Mechanics - II

Test / Tutorial No. :

Div. :

Q1

i) Weidmann - Franz law

ii) $\frac{ne^2\tau}{m}$

iii) $\left(\frac{\partial f}{\partial t}\right)_{\text{Collision}} = 0$

iv) 1

v) $nv/6$

Q2. Energy shifts are analyzed within the framework of perturbation theory in quantum mechanics. When a system is subjected to a perturbing potential, the energy levels of the unperturbed system are shifted. In first order energy shift perturbation theory, ΔE for a given state is proportional to the matrix element of the perturbing potential (V)

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Vivekanand College, Kolhapur (Autonomous)

Department of Physics

M.Sc. Part-I SEM II Internal Examination (2022-23)

Statistical Mechanics

Time : 3.30 pm -4.30 pm Total Marks: 20

Instructions:- 1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q1: **Choose the correct alternative.** **(5)**

1. Entropy per system is …….

a) Always negative b) Always positive c) Always infinite d) Always zero

2.Which of the following is classical statistics.

a) MB statistics b) BE statistics c) FD statistics d) All of these

3.Fermi –Dirac statistics is applicable to the…….

a) electrons b) photons c) molecules d) atoms

4.When a metal is heated, which electrons are excited to the higher energy states?

a) Electrons in the filled shells b) All the electrons in an atom

c) Electrons near the Fermi level d) Electrons very above the Fermi

5.The particles obeying BE statistics are called as…….

a) fermions b) bosons c) photons d) molecules

Q2: **Attempt any ONE.** **(10)**

1. Consider a system M of N non-interacting spin ½ particles placed in uniform magnetic field H. The particle can have only 4 possible orientation $\theta = (0^0, 120^0, 240^0)$
   Find a)Entropy
   b)Magnetization M
2. What is ensemble? Derive the partition function for the canonical ensemble.
   Show that entropy per system is always positive.

Q3: **Attempt any ONE.** **(5)**

1. Consider a 1D chain consisting of small n segment. F is load or force applied on the chain. Let the length of each segment is ‘a’ if it is parallel to the chain and ‘0’ if it is perpendicular to the chain find the partition function and also find the average length.

2. Find the mean value of potential energy if $U(x) = \frac{1}{2} k r^2$

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Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College (Autonomous) Kolhapur

Department of Physics

M.Sc. I Internal Examination, April-2023

Attendance Sheet

Date: **Statistical Mechanics**

Time: 12.00-1.00 p.m.

Roll. No.	Name of Candidate	Sign
1331	Ahiwale Snehal Nitin	
1332	Biradar Anand Nagappa	
1333	Jarkoli Smith Kallappa	
1334	Kavatagi Shivraj C.	
1335	Mithari Shweta Sardar	
1336	Randive Rajshree Mahesh	
1337	Sagar Shivani Dattatryay	
1338	Chuhan Aditi S.	
1339	Shirke Pranali Pradip	
1340	Shirodkar Shubham R.	
1341	Todkar Dnyaneshwari Pandit	

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09943.

Signature of Jr. Super.

विवेकानंद कॉलेज (स्वायत्त) कोल्हापूर.

परीक्षेच्या ——— या विषयाच्या प्रयोग परीक्षा

Internal Practical Examination in Statistical Mechanics

at the M.Sc-I Internal Examination 2022-23

उमेदवाराचा आसन क्रमांक (Candidate's Seat No.) 1359 विभाग (Section)

ESTD JUNE 1954

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्यानुसार दिलेल्या प्रयोग करा.

२. उपकरणांच्या बाबतीत तुम्हाला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.

३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि हा पेपर, पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.

४. सर्व निरीक्षणे कोष्टकाच्या स्वरूपात घ्यावी. यामध्ये सर्व गणना आणि निर्णय हे शक्य तितक्या सुवाच्यपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.

५. प्राथमिक किंवा अंतिम निरीक्षणात संख्यात्मक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा बाजूलाच लिहा.

६. प्रयोगशाळा सोडून जाण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Reac the question carefully and perform the experiment as required.
2. If there be anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you.
3. Before doing any electrical experiment, it is obsolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection, and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form.
   It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(इथून लेखनास सुरवात करा.) (Begin writing here.)

Q1.

1 - $\frac{\partial F}{\partial H}$

2 h^{SN}

3 always negative

Section	Q. No												
	Marks												

E. B.	4	Antisymmetric
Q. No		
	5	$\frac{5R}{2}$

Q 2

(i) An Ensemble is a group of systems that are microscopically different but macroscopically the same.

The macroscopic state could be (E, V, N) energy, volume and particle number.

The microscopic state could be the position and momentum of all 6×10^{23} molecules

The ensemble corresponding to our choice of macroscopic state (E, V, N) is called Microcanonical Ensemble. This include all microscopic state that are compatible with (E, V, N)

The canonical partition function Z_N is

$$Z_N = \int \frac{d^{3N} q \, d^{3N}}{h^{3N} N!} e^{-\beta H(q,p)}$$

$$Z = \sum_i e^{\beta E_i}$$

Z - is partition function

Q. No. | Marks

Q. No. 3

ii) $U = \frac{1}{2} k r^2$

$\langle U \rangle = \frac{1}{Z} \sum_i \frac{1}{2} k r_i^2 e^{-\beta E_i}$

If you have a specific system or potential energy function, you would need to know the energy levels E_i and the corresponding values of r_i for each state.

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Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Autonomous)

Department of Physics

M.Sc. Part-I SEM II Internal Examination (2022-23)

Electrodynamics

Total Marks:20

Instructions:-

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q.1) Choose the correct alternative and rewrite **5 marks**

i) Addition of four vectors $C^{\mu}=(A+B)^{\mu}$ = ….

a) $A^{\mu}+B$ b) $A+B^{\mu}$ c) $A^{\mu}+B^{\mu}$ d) $A^{\mu}-B^{\mu}$

ii) Scalar product of four vectors is invariant under the condition of $\sum_{\mu,=0}^{3} g_{\mu\rho}A^{\mu}B^{\rho} =$ … … …

a) $\overline{g}_{\mu}A'^{\mu}B$ b) $\sum_{\mu,\rho=0}^{3}\overline{g}A'^{\mu}B'^{\rho}$ c) $\sum_{\mu,\rho=0}^{3}\overline{g}(AB)^{\mu}$ d) $\sum_{\mu,\rho=0}^{3} g_{\mu\rho}A'^{\mu}B'^{\rho}$

iii) Four operator $\frac{\partial}{\partial x^{\prime\mu}} = \sum_{\gamma} \frac{\partial x^{\rho}}{\partial x^{\prime\mu}}$. … … … … … ..

a) $\frac{\partial}{\partial x}$ b) $\frac{\partial}{\partial x^{\rho}}$ c) $\frac{\partial}{\partial x^{\mu}}$ d) All of the above

iv) $4(D)$ del operator $\boxdot = \cdots$ … … … ..

a) $\frac{1}{c^2}\frac{\partial}{\partial t^2} - (\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2})$

b) $(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2})$

c) $\frac{1}{c^2}\frac{\partial}{\partial t^2} - \nabla$

d) $(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}) - \frac{1}{c^2}\frac{\partial}{\partial t^2}$

v) Lorentz transformation of position vector ……

a) $x' = \frac{x+\rho t}{\sqrt{1-\beta^2}}$ b) $x' = \frac{x-\rho t}{\sqrt{1-\beta^2}}$ c) $x' = \frac{x+\rho t}{\sqrt{1+\beta^2}}$ d) $x' = \frac{x-\rho t}{\sqrt{1+\beta^2}}$

Q.2. Attempt the following (Any One) **5 marks**

i) Obtain Lorentz transformations of the components of position four vectors.

ii) Derive relation for four potential or relativistic potential.

Q.3. Attempt the following **10 marks**

i) Derive Expression for E.M. field tensor and also covariant from of Maxwell's equations.

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Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College (Autonomous) Kolhapur

Department of Physics

M.Sc. I Internal Examination, April-2023

Attendance Sheet

Date: Electrodynamics

Time: 2.00-3.00 p.m.

Roll. No.	Name of Candidate	Sign
1331	Ahiwale Snehal Nitin	
1332	Biradar Anand Nagappa	
1333	Jarkoli Smith Kallappa	
1334	Kavatagi Shivraj C.	
1335	Mithari Shweta Sardar	
1336	Randive Rajshree Mahesh	
1337	Sagar Shivani Dattatryay	
1338	Chuhan Aditi S.	
1339	Shirke Pranali Pradip	
1340	Shirodkar Shubham R.	
1341	Todkar Dnyaneshwari Pandit	

VIVEKANAND COLLEGE KOLHAPUR
ESTD JUNE 1964
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20/20

08390

Signature of Jr. Super.

विवेकानंद कॉलेज (स्वायत्त) कोल्हापूर.

परीक्षेच्या ——— या विषयाच्या प्रयोग परीक्षा

Examination in Electrodynamics

at the M.Sc-I Internal examination 2022-23 Examination

उमेदवाराचा आसन क्रमांक (Candidate's Seat No.) 1604

विभाग (Section)

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.

२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.

३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्या नंतर, पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.

४. सर्व निरीक्षणे कोष्टकवजा तक्त्यात भरादी. मधल्या सर्व गणना आणि निर्णय हे शक्य तितक्या सुवाच्चपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.

५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा.

६. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there be anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you,
3. Before doing any electrical experiment, it is obsolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection, and obtain the examiner's permission to proceed.
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5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

Q i

i) $A^{\mu} + B^{\mu}$

ii) $\sum_{\mu,\nu=0} g_{\mu\nu} (AB)^{\mu}$

iii) $\partial / \partial x^{\mu}$

Section	Q. No.												
	Marks												

Q. No. iv) $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$

v) $x' = \frac{x+vt}{\sqrt{1+\beta^2}}$

Q2 i) $\nabla\cdot\bar{A}+\frac{1}{c^2}\frac{\partial\phi}{\partial t}=0$

$\nabla\cdot\bar{A}+\frac{i}{icc}\frac{\partial\phi}{\partial t}=0$

$\nabla\cdot\bar{A}+\frac{\partial(i\phi/c)}{\partial(ict)}=0$

But, $\nabla=\left(\hat{i}\,\partial/\partial x_1+\hat{j}\,\partial/\partial x_2+\hat{k}\,\partial/\partial x_3\right)$

$\left(\hat{i}\,\partial/\partial x_1+\hat{j}\,\partial/\partial x_2+\hat{k}\,\partial/\partial x_3\right)\left(A_1\hat{i}+A_2\hat{j}+A_3\hat{k}\right)+\frac{\partial A_4}{\partial x_4}=0.$

$\frac{\partial A_1}{\partial x_1}+\frac{\partial A_2}{\partial x_2}+\frac{\partial A_3}{\partial x_3}=0$

$\frac{\partial A_4}{\partial x_4}=0$

$\boxed{\Box\cdot A_4=0}$

Section	Q. No.												
	Marks												

प्र. क्र. 3

Q. No. i)

$$F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu$$

$$A^\mu = (A^\circ \; A)$$

$$\bar{B} = \nabla \times \bar{A}$$

$$\bar{E} = -\nabla\phi - \frac{\partial \bar{A}}{\partial t}$$

$$F^{\mu\nu} = \begin{pmatrix} F^{00} & F^{01} & F^{02} & F^{03} \\ F^{10} & F^{11} & F^{12} & F^{13} \\ F^{20} & F^{21} & F^{22} & F^{23} \\ F^{30} & F^{31} & F^{32} & F^{33} \end{pmatrix}$$

$$\bar{E} = -\nabla\phi - \frac{\partial \bar{A}}{\partial t}$$

$$= -\frac{\partial \phi}{\partial x_1} - \frac{\partial \phi}{\partial x_2} - \frac{\partial \phi}{\partial x_3} - \frac{\partial A_1}{\partial t} - \frac{\partial A_2}{\partial t} \frac{\partial A_3}{\partial t}$$

$$F^{\mu\nu} = \partial^\mu A^\circ - \partial^\nu A^\mu$$

$$= \partial^\circ A^1 - \partial A^\circ$$

$$= \frac{\partial A^1}{\partial x^\circ} - \frac{\partial A^\circ}{\partial x^1}$$

$$= \frac{\partial A^1}{\partial (ct)} - \frac{\partial (\phi/c)}{\partial x^1}$$

Section	Q. No.												
	Marks												

H. W.
Q. No.

$$F^{01} = \frac{1}{c}\left(\frac{\partial A^1}{\partial t} - \frac{\partial \phi}{\partial x^1}\right)$$

$$(F_1, F_2, F_3) = -\left(\frac{\partial \phi}{\partial x^1} + \frac{\partial A^1}{\partial t}\right) - \left(\frac{\partial \phi}{\partial x^2} + \frac{\partial A^2}{\partial t}\right) - \left(\frac{\partial \phi}{\partial x^3} + \frac{\partial A^3}{\partial t}\right)$$

$$\bar{B} = \bar{\nabla} \times \bar{A}$$

$$= \begin{pmatrix} i & j & k \\ \partial_1 & \partial_2 & \partial_3 \\ A^1 & A^2 & A^3 \end{pmatrix}$$

$$\bar{B} = (\partial_2 A^3 - \partial_3 A^2) + (\partial_1 A^3 - \partial_3 A^1) + (\partial_1 A^2 - \partial_2 A^1)$$

$$(-B_1, -B_2, -B_3) = (\partial^2 A^3 - \partial^3 A^2), (\partial^3 A^1 - \partial^1 A^3), (\partial^1 A^2 - \partial^2 A^1)$$

$$F^{\mu\nu} = \begin{pmatrix} 0 & -E^1/c & -E^2/c & -E^3/c \\ E^1/c & 0 & -B^3 & B^2 \\ E^2/c & B^3 & 0 & -B^1 \\ E^3/c & -B^2 & B^1 & 0 \end{pmatrix}$$

16/20

08389

Signature of Jr. Super.

विवेकानंद कॉलेज (स्वायत्त) कोल्हापूर.

परीक्षेच्या _____ या विषयाच्या प्रयोग परीक्षा

Practical Examination in Electrodynamics

at the M.Sc - I Internal Examination 2022-23 Examination

उमेदवाराचा आसन क्रमांक (Candidate's Seat No.) 1610

विभाग (Section)

VIVEKANAND COLLEGE, KOLHAPUR (Autonomous) ESTD JUNE 1964

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे दिचारलेला प्रयोग करा.

२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.

३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्या नंतर, पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.

४. सर्व निरीक्षणे कोष्टकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे शक्य तितक्या सुवाच्यपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.

५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा.

६. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there be anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you,
3. Before doing any electrical experiment, it is obsolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection, and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form.
   It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

Q1.

i) $A^\mu + B^\mu$

ii) $\sum_{\mu,\nu=0} \bar{q}_{\nu\mu} (AB)^\mu$

iii) $\partial/\partial x^\nu$

Section	Q. No.												
	Marks												

प्र. क्र. / Q. No.

iv) $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$

v) $x' = \frac{x+vt}{\sqrt{1+\beta^2}}$

Q2.

i) We have Lorentz equation,

$$\nabla\cdot\bar{A}+\frac{1}{c^2}\frac{\partial\phi}{\partial t}=0.$$

$$\nabla\cdot\bar{A}+\frac{i}{icc}\frac{\partial\phi}{\partial t}=0.$$

$$\nabla\cdot\bar{A}+\frac{\partial(i\phi/c)}{\partial(ict)}=0$$

$\nabla = \left(\hat{i}\,\partial/\partial x_1+\hat{j}\,\partial/\partial x_2+\hat{k}\,\partial/\partial x_3\right)$

Above eq'n becomes,

$$\left(\hat{i}\,\partial/\partial x_1+\hat{j}\,\partial/\partial x_2+\hat{k}\,\partial/\partial x_3\right)\left(A_1\hat{i}+A_2\hat{j}+A_3\hat{k}\right)+\frac{\partial A_4}{\partial x_4}=0$$

$$\frac{\partial A_1}{\partial x_1}+\frac{\partial A_2}{\partial x_2}+\frac{\partial A_3}{\partial x_3}=0$$

$$\frac{\partial A_\mu}{\partial x_\mu}=0.$$

$$\boxed{\partial\cdot A_\mu=0}$$

Section	Q. No.												
	Marks												

Q. No. 2

i) $F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu$

$A^\mu = (A^\circ A)$

$\overline{B} = \overline{\nabla} \times \overline{A}$

$E = -\nabla\phi - \frac{\partial A}{\partial t}$

$$F^{\mu\nu} = \begin{pmatrix} F^{00} & F^{01} & F^{02} & F^{03} \\ F^{10} & F^{11} & F^{12} & F^{13} \\ F^{20} & F^{21} & F^{22} & F^{23} \\ F^{30} & F^{31} & F^{32} & F^{33} \end{pmatrix}$$

$\overline{E} = -\nabla\phi - \frac{\partial \overline{A}}{\partial t}$

$= -\frac{\partial \phi}{\partial x_1} - \frac{\partial \phi}{\partial x_2} - \frac{\partial \phi}{\partial x_3} - \frac{\partial A_1}{\partial t} \frac{\partial A_2}{\partial t} \frac{\partial A_3}{\partial t}$

$F^{\mu\nu} = \partial^\mu A^\circ - \partial^\nu A^\mu$

$= \partial^2 A^1 - \partial^1 A^\circ$

$= \frac{\partial A^1}{\partial x^\circ} - \frac{\partial A^\circ}{\partial x^1}$

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

$$= \frac{\partial A^1}{\partial(ct)} - \frac{\partial(\phi/c)}{\partial x^1}$$

$$F^{01} = \frac{1}{c}\left(\frac{\partial A^1}{\partial t} - \frac{\partial \phi}{\partial x^1}\right)$$

$$(E_1, E_2, E_3) = -\left(\frac{\partial \phi}{\partial x^1} + \frac{\partial A^1}{\partial t}\right) - \left(\frac{\partial \phi}{\partial x^2}, \frac{\partial A^2}{\partial t}\right) -$$

$$\left(\frac{\partial \phi}{\partial x^3} + \frac{\partial A^3}{\partial t}\right)$$

$$\bar{B} = \bar{\nabla} \times \bar{A}$$

$$= \begin{pmatrix} i & j & k \\ \partial_1 & \partial_2 & \partial_3 \\ A^1 & A^2 & A^3 \end{pmatrix}$$

$$\bar{B} = (\partial_2 A^3 - \partial_3 A^2) + (\partial_1 A^3 - \partial_3 A^1) + (\partial_1 A^2 - \partial_2 A^1)$$

$$(-B_1, -B_2, -B_3) = (\partial^2 A^3 - \partial^3 A^2), (\partial^3 A^1 - \partial^1 A^3), (\partial^1 A^2 - \partial^2 A^1)$$

$$F^{\mu\nu} = \begin{pmatrix} 0 & -E^1/c & -E^2/c & -E^3/c \\ E^1/c & 0 & -B^3 & B^2 \\ E^2/c & B^3 & 0 & -B^1 \\ E^3/c & -B^2 & B^1 & 0 \end{pmatrix}$$

"Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. BapujiSalunkhe

Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Autonomous)

Department of Physics

M.Sc. Part-I SEM II Internal Examination (2022-23)

Atomic and Molecular Physics

Time :- 11.00 am-12.00 noon Total Marks: 20

Instructions:-

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q1. Fill in the Blanks (1 mark for each) **(5)**

1. What are the wave number range for mid IR region?

A) 12800-4000 cm^{-1} B) 4000-2000 cm^{-1} C) 4000-200 cm^{-1} D)200-10 cm^{-1}

2.The most common source of IR spectrometer is…….

A) Zirconium B) Ytterbium C) Nernst Glower D) Erbium

3.What is the selection rule of AHO for vibrational energy levels transitions.?

A) (1, -1) B)(0, 1) C) $\pm 1, \pm 2, \pm 3$ .... D) (1, 1)

4. B is rotaionl constant and is given by

A) $B=\frac{h^2}{8\pi^2 Ic}$ B) $B=\frac{\hbar^2}{8\pi^2 Ic}$ C) $B=\frac{h}{8\pi^2 Ic}$ D) $B=\frac{\hbar}{8\pi^2 Ic}$

5. For prolate symmetric top the condition is…….

A) $I_A=I_B=I_C$ B)$I_B=I_C>I_A$ C) $I_B=I_C<I_A$ D) $I_B=I_C \geq I_A$

Q2. Answer the following (Any one) **(5)**

1. Derive the expression of energy for perfectly elastic body performing oscillations.
2. Obtain the expression for the energy and a spectra for rigid diatomic molecule.

Q3. Answer the following (Any one) **(10)**

1. Write short note on P, R and Q branch with diagrams.
2. Explain linear, symmetric, anti-symmetric and spherical top molecules.

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-Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College (Autonomous) Kolhapur

Department of Physics

M.Sc. I Internal Examination, April-2023

Attendance Sheet

Date: Atomic and Molecular Physics
Time: 2.00-3.00 p.m.

Roll. No.	Name of Candidate	Sign
1331	Ahirwale Snehal Nitin	Ahirwale
1332	Biradar Anand Nagappa	A.B.
1333	Jarkoli Smith Kallappa	Jarkoli
1334	Kavatagi Shivraj C.	S.C Kavatagi
1335	Mithari Shweta Sardar	Mithari S.
1336	Randive Rajshree Mahesh	Randive
1337	Sagar Shivani Dattatryay	Sagar D
1338	Chuhan Aditi S.	Aditi S.
1339	Shirke Pranali Pradip	Pranali S.
1340	Shirodkar Shubham R.	Shirodkar
1341	Todkar Dnyaneshwari Pandit	Pandit Todkar

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34444
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

18/20

Signature of Supervisor	

Suppliment No. : Internal Exam
Roll No. : 2022-23
Class : M.Sc - I

Subject : Atomic and Molecular physics
Test / Tutorial No. :
Div. :

Q1.

1. 200 - 10 cm^{-1}

2. Zirconium

3. (0, 1)

4. $B = \frac{\hbar}{8\pi^2 I c}$

5. $I_B = I_A = I_C$

Q2.

2) For rigid diatomic molecule, total energy is the sum of its translational and rotational and vibrational energies.

1) Rotational energy (E_{rot}) :-

The rotational energy of a diatomic molecule is given by

$$E_{rot} = J(J+1)\frac{\hbar^2}{2I}$$

E_{rot} - rotational energy
J - rotational quantum number
$\hbar$ - reduced Planck's constant = $h/2\pi$
I - Moment of inertia of the molecule

② Vibrational energy

The vibrational energy of a diatomic molecule is given by

$$E_{vib} = (n + 1/2)\hbar\nu$$

E_{vib} - Vibrational energy
n - vibrational quantum number
h - Planck's constant
ν - vibrational frequency of the molecule

The total energy is the sum of rotational and vibrational energies

$$E = E_{rot} + E_{vib}$$

As for the spectrum, the rotational and vibrational transitions in a diatomic molecule give rise to specific lines in the infared and microwave regions of the electromagnetic spectrum.

The rotational spectrum can be expressed by the rotational selection rule

$$\Delta J = \pm 1$$

Vibrational spectrum can be expressed by vibrational selection rule,

$$\Delta n = \pm 1$$

Q. 7

a) The classification of molecules into different types such as linear, asymmetric, antisymmetric and spherical top, based on their molecule geometry and rotational characteristics.

i) Linear molecules:-

Linear molecules have a straight-line arrangement of atoms. The central atom is bonded to two other atoms and the bond angle is 180°. e.g CO_2, N_2, HCl

ii) Symmetric top molecules:-

Symmetric top molecules have a symmetric distribution of atoms around the central axis but they are not linear. The M.I is different along different axes.

examples:- H_2O, NH_3, H_2S.

iii) Antisymmetric top molecules:-

Antisymmetric top molecules have a less symmetric distribution of atoms and they have two moments of inertia that are equal.

e.g H_2O_2

iv) Spherical top molecules:-

Spherical top molecules have a high degree of symmetry, with all three principal moments of inertia being equal.

e.g CH_4, CCl_4, NH_3.

Linear molecules: $\Delta J = \pm 1$

Symmetric top molecules: $\Delta J = 0, \pm 1$

Anti-Symmetric top molecules :- $\Delta J = 0, \pm 1$

Spherical top molecules :- $\Delta J = 0, \pm 1, \pm 2$.