## Vivekanand College, Kolhapur. (Autonomous) Department of Physics Internal Examination Notice 2019-20

Date:11 September 2019

All students of class B.Sc. I, B.Sc. II and B.Sc. III are hereby noticed that the first term internal evaluation examination is scheduled as per following time table. Nature of question paper:

For B.Sc. I: Long answer question (Any one from given two questions) for 10 marks

Short answer question (Any two from given four questions) for 10 marks

For B.Sc. II: Long answer question (Any one from given two questions) for 10 marks

Short answer question (Any two from given four questions) for 10 marks

For B.Sc. II (Astro): Long answer question (Any one from given two questions) for 10 marks

Short answer question (Any two from given four questions) for 10 marks

For B.Sc. III: Long answer question (Any one from given two questions) for 10 marks

Short answer question (Any two from given four questions) for 10 marks Internal Evaluation Examination 2019-20. SEM I, SEM III and SEM V Time Table

Sr. No.	Class	Paper	Date	Time
1.	B.Sc. I	Paper I	23/09/2019	11:00 am to 12:00 pm
2.	B.Sc. II	Paper III	23/09/2019	11:00 am to 12:00 pm
3.	B.Sc. II (Astrophysics)	Paper I	25/09/2019	11:00 am to 12:00 pm
4.	B.Sc. III	Paper V (section I)	26/09/2019	11:00 am to 12:00 pm
		Paper V (section II)	-	01:00 am to 2:00 pm
		Paper VI (section I)	27/09/2019	11:00 am to 12:00 pm
		Paper VI (section II)	-	01:00 am to 2:00 pm





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

Shri Swami Vivekanand Shikshan Sanstha's

# Vivekanand College, Kolhapur

(Autonomous)

# **Department of Physics**

## Internal exam (2019-20)

### B.Sc.III Sem V

# Attendance Sheet

Roll No.	Name Of The Student		Sign	ature	1
8001	Chougule Abhijeet Bajirao	Allougule.	Anougule	Providuk	Frink
8002	Dalvi tejas chetan	TO Ila		Dedvi	Tran
8002	Dinde Akash Sadashiy	Ands.	Pande	Ende	tente
8003		T		Taikingaol	Soiland
8004	Gaikwad Suraj Dhananjay Ghosalkar Pranav Shankar	- highward	Gritand	FT .	Poncsalka
8005		Othoalter	(threaka		
Contract Sector	Harshad Sitaram Katroot	Ikation,	HADRET	Halsoy	Hattand
8007	Jadhav Pratiksha Harish	Jadian	Jadhav	Jadian	Jadiial
8008	Joshi Sourabh Kiran	1	1	To	Con
8009	Kamble Prasad Vilas	40.	"RE	ER.	ER.
8010	Kumbhar Prathmesh Mallikarjun	P.M. Kumbhar	P. M. Kumbhar	P.M.Kumbha	
8011	Kumbhar Jayvant Rajaram	YRK_	PRK	YRK.	URK
8012	Manasi Vinayak Kulkarni	Hansi	Hamei	Manse	Hansi
8013	Manasi Kahnderao Jagadale	Jajdal	Tagdle	Jageh_	Jidgen
8014	Nalavade Ankita Amar	Ajalwade	Alahunde	Aluade	Acounde
8015	Paranjape Anish Shriram	AR	Te	AP -	TP
8016	Patil Amruta Bhuigonda	A.Patil	A. Patil	flat.	Apatil
8017	Patil Sujata Anandrao	Fatil	Feitil	Falil	Factil
8018	Patil Jeevan Maruti	stipatit	stipatit	Fratit	-orfatit
8019	Patil Tejaswini Krishna	Fatt	Fat	Ett	Tata
8020	Paul Jonathan Sanjay	1 Parts	Yaut	Gaut	it -
8021	Potdar Aishwarya Sharad	Ratdar	Acton	Actuby	Acidir
8022	Radhika Baburao Shinde	Rating	Particka	Finka	-Bitto ita
8023	Ragini Jayprakash Benake	Bonate	Benalee	Benake	Berati
8024	Sandhya Sudhakar Dingane	Sphinam	Show	Sphingm	- Showen
8025	Sawant Rohit Ramchandra	Eriobit	Andut	Edit	6Pehil
8026	Sourabh Vijay Ghatage	18	78-	28-	292
8027	Sujit Dinkar Katale	S.P.K	J.P.K.	S.P.K.	S.P.K
8028	Swaranjali Sanjay Shinde	Finde	Sinde	Frinde	Fairle
8029	Swarupa Baburao Dhavale	Tewamp	Swang	Boyanup	Town
8030	Tanvi Vikas Mohite	GTP .	671.	OT.	OT
8031	Tibile Rohan Arjun	Echar	Tohan	Rahan	Rohm
8032	Tushar Arvind Patil	anti	ureit	-utett	USIT



8033	Yogita Vishnu Zuguge	Fregita Degita Jogita - Vegita
Internal	Examinar	

NOCOLLEGE ESTD 1964 vionomou

### Vivekananda College Kolhapur (Autonomous). Department of Physics: Internal examination2019-20 B.Sc. III Semester V Subject: Atomic and Molecular Spectra, Astronomy and Astrophysics

Marks: 20 (Each question carry one mark)

Time: 20 min

(10)

(10)

#### Q.1 Attempt any ONE

- Explain the principle of electron-synchrotron with special reference to two-step acceleration.
- Discuss the principle of proton-synchrotron with a special reference to two step acceleration.

#### Q.2 Attempt any TWO

- 1. What are nucleons? Explain their intrinsic properties.
- 2. What is the shape and size of nucleus?
- 3. Discuss different methods used to measure nuclear radius.



SUPPLIMENT	E, KOLHAPUR (AUTONOMOUS) Signature
	of Supervisor
Suppliment No. :	subject: Elements of Modern physics
Roll No. : 8032	Test / Tutorial No.: Internal Examination (2022-23)
Class : BSC-III	Div. : 12/20
; allon at bailyon	alled adaption of a hadra
1. out le viel- 151	A approvale to the state
Toman Signation	Casting the second
I when two or more no	umber of electrons from one to another atom then bone
atom may transfer	to another arom then bond
is formed	100
> ii) Ionic.	
A un classical F	Ynmerica law Provau al
I In the classical E	xpression for energy of molecule, there is no restriction
on the value of -	
- iil L.	
SMIL.	
a In rotational Spectro	, the selection rule of or
3] In rotational spectro transition is	b
$\pm \pm $	
MIDDE-+.	
7) The spectral lines for	nown as
J JIE Spearry and for	
exciting they are k	nown as

In experimental set up of Raman Effect, cylinder 'c' is filled with saturated selution of 5) Sodium Nitrate. OF Q3. é Classical Theory of Raman when an electric field is applied to or 4. the polarization takes place of th molecule induced tonie dipoli moment the. molecule & is produced E to 6=0 00 000 No clechic field applied Electric field The magnetuide of Induced dipole moment (p) to the shength of applied is directily proportional E. PXE etechic fiel P=xE called as polarzibility where x is the applied electric. field is The shength of given by, E= Eo SinzDot -(2) using eq (2) in eq (1) P=~(Eo sinapot)-JUNE -(3 1964

vibrational motion in the presence of the external electric field. x = x + B sin 2 Vibt (4) B= Range of potarte Using eq (4) is eq (3). p= (x + B sin 2 Vibt). (2 E sin (2 Vibt) - sin (Vot p = x + E sin 2 Vibt) (2 E sin (2 Vib) - sin (Vot = x to sin 2 Vot B (cos ( Vvib - Vot) - 505 (V.th) + vot) - Jot)zt - 806 (Duibt Do)zt = ~ Esin 2 Vot B cos (Divib-Dot)2t from above eq. we come to known that. There are three to be to known that. there are three types: ] Dot = Rayleight lines 3) Drib + Not = Anti-stokes lines Rayfigh stokes mon res · Unitation of classical Theory of Raman effect I The stokes and Anti-stoke fines are emitted for the same molecules, But it is from not because they have different intensities JUNE

92. Quantum Theory of Raman Effect 0 Juit 4 Vribt Jot Z The moterates atoms to the molecules ane stable 5-1- (+) Totalia B ROS APUR EKA JUNE d

Name: Sapana Raviranjan Singh. - शिक्षणमहर्षी डॉ. बापूजी सालुंखे 27456 Shri Swami Vivekanand Shikshan Sanstha Kolhapur's Brasilente . **VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)** SUPPLIMENT Signature Ilimizeit ... You anallimiz of Supervisor Subject: Physics Suppliment No. : 3/1. 8015" Roll No. Test / Tutorial No. : Internal Exam Bisc. III Physics 18/20 Class Div. : Q 1)-1 a dimlar When two or more number of electrons from one atom may transfer to another atom then 2 ionic bond is formed 2) In the classical et: expression for energy of rotating diatomic molecule, there is no restriction on the walke of 2) L In rotational spectra, the selection rule for transition is 8) AJ = +1 The spectral lines found on low frequency side of exciting lines are known as 1) Stokes lines 52 In experimental set up of Raman Effect, cylinder 'C' is filled with saturated solution of 1) Sodium Nitzate. site ul spilling COLLE ESTD JUNE 1964 · Contario ulonomous

Contract. 9 2)2 Diatomic molecule as rigid rotator and its Diatomic molecule means arrangement of two atoms in the molecule which is can be simillar or dissimillar. Consider a molecule as rigid rotator moving in its rotational energy states with angular velocity w& I be the to an instant of Inertia. mini tet mis be the masses of the molecule with center printer to perpendicular to the plane of mass mi & m2. T, & r2 are the distance from perpendicular axis 'o' of mass m, & m2. Hence it is given by nothand minine maine to the former lander As & is the distance between m, & m2, then tit is given by  $\pi = \pi; + \pi_2$ Substituting the value of tr, integ () we get,  $\frac{m_1 x}{(m_1 + m_2)} = \frac{m_2}{m_2}$  $m_1(\gamma - \gamma_2) = m_2 \sigma_2$ Simillarly for tor get  $m_1 - m_1 \pi_2 = m_2 \pi_2$  $m_1 r = m_2 r_2 + m_1 r_2$  $m_1 x = x_2 (m_1 + m_2)$  $\frac{1}{m_1 + m_2} = \frac{m_1 \alpha}{(m_1 + m_2)}$ 

 $g_{2}^{2}$  2) The M-I of molecule as rigid rotator 8 its is given by  $T = m_1 r_1^2 + m_2 r_2^2$ Devalent Bond substituting the value of rig zz we get  $I = m_1 \left( \frac{m_2 \gamma}{m_1 + m_2} \right)^2 + m_2 \left( \frac{m_1 \gamma}{m_1 + m_2} \right)^2 + m_2 \left( \frac{m_1 \gamma}{m_1 + m_2} \right)^2 + m_2 \left( \frac{m_1 \gamma}{m_1 + m_2} \right)^2$  $m_1 + m_2 = m_1 + m_2 + m_2 + m_1 + m_1 + m_1 + m_1 + m_2 + m_1 + m_1$ magge between their carent mucker, to then the : I = mim2 2 bennet si passi fuelovas ship grow mitmens aning 11 12 I = 482 10 and 3 where u= mim2 suppion of to mitma haster the sample of coviend In classical expression for energy of rotating diatomic molecule, there is no restriction on the in al electron proster and in forestation beniof LE Iwit sindi ash proto with 1 - 1. <u>E =  $1 \frac{T^2 \omega^2}{T}$ </u>  $\frac{1}{E} = \frac{1}{2} \frac{L^2}{T}$ Substituting the value of I from eq" 3 we get, ESTD  $E = 1 L^2 - 2 L T^2$ Equation (4) gives the energy state of diatomic molecule as rigid rotator

(33) i) Types of bonds. A molecule is a stable amangements not atoms There are 3 types of boods. There are 3 types of boods. 2 Covalent Bond. 2) "Janic" Band " to sular site printitude 3 3) No Bood V covalent Bond Brmation: When one or more pair of electron is shared from two atoms; then the shared electrons spends more time win the avanage between their parent nuclei, to then the covalent Bond is formed The electron spends more time between the gloms rather the moving else where. The fig shows H covalent Bond of 12 molecules. Covalent Bonding This in the example of covalenct Bond. 2) Ionic Bond formation. When two or more number of electrons from one atom may transfer to another atom then ionic bond is formed. since at in this to toto unon

Carl Trans Article	
।। ज्ञान, विज्ञान आणि सुसंस्व	हार यांसाठी शिक्षण प्रसार ।। - शिक्षणमहर्षी डॉ. बायूजी साखुंखें 27453
Shri Swami Vivekanand S	Shikshan Sanstha Kolhapur's
VIVEKANAND COLLEGE, I	KOLHAPUR (AUTONOMOUS)
SUPPLIMENT Name: - Aaryan · Patil	Signature of Supervisor
Suppliment No. :	Subject: Physics Elements of Test / Tutorial No.: Internal enam
Roll No. : 8012	Test / Tutorial No.: Internal enam
Class : BSC - II	Div.:
A state of the second stat	317
QI. JANA	
	कामंग कि
1) (ii) ionic	
2) (ii) [	the state of the s
	State -
3) $(i) A J = \pm 1/2$	oic a
	neery e
4) W Stopes lines	
5) (i) Solium Nitrate	04
- S/ U Souman Marrare	
02	
i) In the quartum	theory of Roman alkat
the three visible	lines are except in
Rayleigh lize the	stokes live and the
artistapes line.	
The Rayligh lie	ne is accoled by V the
- Stokes line is	leasted by V'-V another
antistakes line	is denoted by V' + Vict 1964
franke file tot line	a biomicu?

leia ne 10 . VI D VI V NN EKAN JUNE APU 0 mo 00 0

which is being transferred is in regative. To The antistekes line, the energy which is teansflered is in the positive and beau leverking of boads takes place. There are a few applications of Rama effect 1. It is used to describe the Structure of the molecules. 2) It is used to calculate the estational and the vibrational energies of the molecules 3. It is used to describe the composition of the molecule. 4. It is used for the real arrangement of atoms in the molecule 06 quantum properties of the molecule Q3. Dan the basis of bond formation, those are four types of bond formations which takes place in the molecule. 1. Ionic bond 2. Covalent bond 3. Van dez wells 4. No bonds

@ I enic bend: - I to formation takes place when one or more electron from the when one or molecule is shored to the atom of one molecule is shored to the otem of another molecule salled as an ionic bond tence ionic bond is strong in entire (i) (avalent bond :- Heat is required in order to supply enternal every for the bond transfer to take place. In constant band, the atoms are shared in between two atoms of two noteules. en: - Nat and chi ion form Nall molecule which is complex in nature (iii) Van der Wools bond: The bond which is borned in lectureen two atoms of two molecules using that der Wool's borres are colled as Van der Waals bond. These Van der Wool's forces may be strong or weak. These forces of attraction depend on the heat supplied. (iv) Nobord :- When sometimes during a reaction, the ion enchange does not take place. So these is sometimes no bond formation in petween the two atom of the two molecules Heave in Of such situations, no bond is formed So sometimes no band is formed during ion enthange in the ESTD the atoms

### Vivekananda College Kolhapur (Autonomous). Department of Physics: Internal examination 2019-20 B.Sc. III Semester V Subject: Classical mechanics

Marks: 20 (Each question carry one mark)

#### Q.1 Attempt any ONE

Ť-

Time : 20 min

(10)

(10)

- 1. Obtain an expression for the divergence of vector field in orthogonal curvilinear coordinate system. Extend the above formula in spherical polar co-ordinate system.
- 2. Obtain an expression for the curl of vector field in orthogonal curvilinear co-ordinates.

#### Q.2 Attempt any TWO

- 1. Obtain an expression for gradient of a scalar field in orthogonal curvilinear co-ordinate system.
- Obtain Laplacian operator in orthogonal curvilinear co-ordinate. Extend the result in cylindrical co-ordinates.
- 3. Describe spherical polar co-ordinate system.



Name: - Girish Chandrakant Mone. 20 Class - BSC - III Div-B Roll No - 7243 Internal Exam 8031 VIVERANAND COLLEGE, KOLHAPUR. Q1 With the correct alternative. 1) Mass is the measure of inertia in linear motion. 2) Acceleration of a body tolling down in an inclined plane is independent of mass of the body. Force in rotational motion is analogous to torque in translation motion. I Moment of mertia of a spherical shell about its diameter is 2 m R<sup>2</sup> Q.2 Answer of the following question. 2 Explain apology of rotational motion with translation motion. > ) It is noticed that there is an analogy between varies physical quantity in rotational & translitional motion, 2) In notational motion about a fixed axies, the moment of inertia (I) is analogy us to the mass (m in linear motion. But moss is the linear motion is the major of inertia of the body. 3) There for, moment of inertia is abo reporded as the notational inertia. 4) The moment of inertia of the body is case of, notational motion plays, the same roll of the mass of body in translatory motion. 5) In case of translation motion the inertia of the body depends totaly upon its mass, but in case of rotational motion on the moment of inertic of the body, and on not only depends on theouse given axis of rotation.

Stor transford 5) The malagy between voirus physically quantities notion to say to motion Transiational motion Rotational motion 1) Mass = m Moment of mertia = ] 2) Displacement = 3 or x Angular displacement = 0 Velocity = v Angular velocity = w 4) Accelaration = a Angular accelatation = ~ 5) force = f = mo Torque = T = Id 6) Linear Momentum = P= mr Angular momentum = L = Ius 7) kinetic energy = 1 mv2 Rotational K.E. = 1 5w2 2) Work done = F.S. Work done = I.Q 8.2 Derive and expression of M.I of a solid cylinder about its axis of symmetry. > ) Let M be the mass, R be the radius & L be the length of the solid, cylinder × X or aff 2) The mass per unit length of the solid cylinder is M/2, Let yy' be the dris passing through its center o and perpendicular to its own aris 2 2 as shown in, 1. Inches NAU .

3) To find its moment of inertia imagin that the cylinder to be made up of large no of this disc lat, we us entired consider one of usch disc' & from a the thikness of the that a distance disc is dr obusly, mass of the disc is (m/L) dx 4) There fore moment of inertia of disc about it diameter = Mass of disc × (radius)2 = M dx. R<sup>2</sup> According to the principal of parallel axis a moment of inertia of the disc about the oxis.  $YY'=m dx R^2 + M dx x^2$ s) The moment of inertia of the so whole cylinder about the oxis rr' can be obtained by interprotion the above egn between the limits x=0, to 1/2 and multiplying the result by ? 5) There fore the moment of inertia of the cylinder about the axis Yy' is, 42 I= fdI = 2 (m/2 Rt/2 dz + m/2 x2 dz)  $= 2 \frac{m}{2} \left[ \frac{R^4}{4} z + \frac{\alpha^3}{2} \right]^{1/2}$ 2 m m [ R4. L + 13  $I = m \left[ \frac{R^4}{4} + \frac{l^2}{4} \right]$ This is the required expression.

- Darshan shivaji Naik. - BSC. II Div = B. ROII NO. 7255, Physics 8033 Class sem I INTERNAL EXAMINATION PHYSTCS Q.1. Explain abalogy of totational motion with translational motion. > i) It is noticed that there is an analogy between Various physical quantities in totational and translational motion. ii) In totational motion about a fixed axis, the moment of inertia (I) is analogues to mass (m) In linear motion. But mass is the linear motion is the measure of inertia of the body. iii) therefore, moment of inertia is also regarded as the totational motion. iv) The moment of inertia of the body in case of rotational motion plays the same role as the body in translatory motion V) In case of translatory motion, the inertia of the body depends totally upon its mass, but in case of totational motion the moment of inertia of the body not only depends on the mass of the body but also on distribution of mass about the given axis of rotation. vi) The analogy between various physical quant. ities in two types of motion. Translational Motion Rotational Motion Sr. NO Moment of inertia = I Mass = pr Displacement - S course Angular displacement. Angular velocity = W JUNE Velocity 3

Name

Page No.: Date: 4. Accelaration - a Angular Accelaration 5. Force = F = ma. Torque = I = Jx. 6. Linear Momentum Angular momentum an an at Predrow and have a LIE I've Mations chycical gumptities in firtan and 7 kinetic energy Potational K.E. isoment of inething (I) is analogue to t in nimed partice But trace is the I rait 8. work dones fish work done I.O. iii) therefore is to prover at india 19 also as the total ideal landitop. 2) Derive an expression for M. D of a sould cylinder about vits axis of symmetry -> 1) Let M be the mass, R be the radius and Le the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he the length of the isot is cylinder is he and there is the tip the safet of modiles 2) The mass per unit length of the sould cylind or let is MILLETOYY be the axis passing thro ugh its centre o and perpendicular to its own axis XX! as shown in fig. 3) To find its moment of inertia imagine that the cylinder to be made up of large number of this discs? Let us consider ope of such disc at a distance se from o. The thickness of the disc is dre. obviously mass of the disc is

(M/L) de.

Page No.: Date: / / ( 4) Therefore, moment of inertia of the disc about its diameter, mass of disc x (radius)2 n dre. R2 4) According to the principle of parallel axes a moment of inertia of the disc about the aseis YY' - m dre R2 1 m dre. 222. 5) The moment of inertia of the whole cylinds about the ase is yy' can be obtained by integrating the equation between the limits & = 0 to L12 and multiplying the result by 2. 6) Therefore, the moment of inertia of the cylinder about the axis YY' is,  $J = \int dI = 2 \int \left( \frac{m_{l}}{r_{j4}} ds + \frac{m_{l}}{2} s^{2} ds \right)$  $= 2 \frac{m}{2} \frac{R^{4}}{4} \frac{R^{4}}{3} \frac{1}{4} \frac{1}{3} \frac{1}{4} \frac{1}{3} \frac{1}{4} \frac{1}{3} \frac{1}{3}$  $\frac{2}{2} \frac{1}{2} \frac{1}{4} \frac{1}{2} \frac{1}{2} \frac{1}{8} \frac{1}{8} \frac{1}{3}$  $2 \frac{m}{2} \frac{R4.L}{8} + \frac{L3}{24}$  $m \begin{bmatrix} R4 \\ 4 \end{bmatrix} \begin{bmatrix} 12 \\ 12 \end{bmatrix}$ This is the required expression.

Name :- Aniket Ananda Metkar. (-20) class - Bisc - III Div-Roll NO - 8030 (B.SC-I.72.48), Sub: Physiecs (Internal) Vivekanand Collage, kolhopur. Q1 write the correct alternative. 1 Mass is the measure of inertia in linear motion. 2 Acceleration of a body rolling down in an inclined. plane in independent of Mass of the body. s Force in rotational motion in analogues to torque in translation motion. 4 moment of inextia of a spherical shell about its diameter is  $\frac{2}{3}$  mr<sup>2</sup>. Q2 Answer the following question. ) Explain analogy of rotatinal motion with translation -al motion. -> O It is noticed that there is an analogy between various physical quantities in rotational and translational motion. @ In solutional motion about a fixed axis, the moment of inertia (I) is analogues to the mass (m) in linear motion. But mass is the linear motion is the measure of inestic of the body. 3 Therefore moment of inertia is also regarded as the rotational inertia. @ The moment of inestia of the body in case of rotational motion plays the same options the mass of the body in translatory motion.

OIn case of translatory motion, the inextia of the body depends totally upon its mass, but in case of solutional motion the moment of inestia of the body not only depends on the mass of the body but also an distribution of mass about the given axis of rotation. @ The analogy between various physical quantities in two types of motion. Sr. Transtational Motion Rotational Motion. NO Mass = m Moment of intestic - I 1 2 Displacement = 5 or 2e Angulax displacement-Q Angular velocity = w 3 velocity = Angular Accelaration= & 4 Accelatation = a - T 5 Force = F - ma Torque work done = T.O. 6 work done = F.S Angular Momentum=1= Tw 7 Linear Momentum =P = my 8 Kinetic energy = 1 mv2 Rotational KE = 1 Iw2 2 Devive an expression for M-I of a solid cylinder about its axis of symmetry. > O Let M be the mass, R be the radices and L be the length of the Solid Cylinder. 4/2 -K-DEX

PAGE: DATE: / / @ The mass per unit length of the solid cylinder is M/L Let YY be the axis passing through its centre and perpendicular to its own axis xx as shown in Fig. 3 To find its moment of inextia, imagine that the Cylindes to be made up of large number of thin discs. Let us consider one of such disc at a distance x from o. The thickness of the disc is dx. obviously, mass of the disc is (M/L) dx @ Thesefore, moment of inestia of the disc about its diameter = mass of disc x (radius)?  $= \frac{m}{l} dx \cdot \frac{R^2}{4}$ @ According to the principle of parallel axis a moment of inestia of the disc about the =  $\frac{m}{l} dx \frac{R^2}{r} + \frac{M}{l} dx \frac{x^2}{r}$ axis 3 The moment of inextia of the whole cylinder about the axis yy' can be obtained by integration the above equation between the limits x = 0 to 1/2 and multiplying the result by 2 @ Therefore, the moment of intertia of the cylinder about the axis yy' is, SdI = 2 ( ( M/ R' dx + M/ z dx)  $\begin{bmatrix} R^4 & L & + 1^3 \\ -4 & 2 & -8 \times 3 \end{bmatrix}$ 2 <u>m</u>  $2 \frac{m}{L} \left[ \frac{R^4 L}{B} + \frac{L^3}{24} \right]$  $= m \left[ \frac{R^4}{4} + \frac{L^2}{12} \right]$ This is the required expression.

### Vivekananda College Kolhapur (Autonomous). Department of Physics: Internal examination 2019-20 B.Sc. III Semester V Subject: Mathematical Physics

Marks: 20 (Each question carry one mark)

### Time : 20 min

(10)

(10)

#### Q.1 Attempt any ONE

- 1. Discuss Hamilton variational principle.
- 2. Derive Hamilton's canonical equation of motion from variational principle.

#### Q.2 Attempt any TWO

- 1. State equivalence of Lagrange's and Newton's equations.
- 2. Write a note on degree of freedom and constraints.
- 3. What is relation between H and L?



।। ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।। - शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34051 Shri Swami Vivekanand Shikshan Sanstha Kolhapur's VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS) Signature SUPPLIMENT of Supervisor subject: mathematical physics Suppliment No. : : 8031 Roll No. Test / Tutorial No. : BSC-TTT Class Div. : Q. 1. The dévergence of vector bimetion may be obtained from Gauss divergence ducorers Gauss dévergence theorem in Ahs: Vector analysis is given by  $(\nabla A) dv = \int \vec{A} ds$  $\vec{A} = \vec{A}_1 \vec{U}_1 + \vec{A}_2 \vec{U}_2 + \vec{A}_3 \vec{U}_3$ where By the mean value theorem tok integrals, we write du'A SSI du = SJ 3 ds div À = lim J À ds do to Js du Now consider the valence dement AV of individesimal parallelopiped having edges hidu, hidu & hidu Let us bind birest component of ( A ds along 4 as

piped at the face obne having area ha ha dua dua. The energy energy leaves the parallelopiped at the face Akar having the same area he he due due energy entering is supposed to be -ve & that leaving is the Therebore we can write, Energy leaving through AKOT = A hzhzduzduz + 2 Energy leaving through AKOT = A hzhzduzduz + 2 Du, (A, h2 b3) du, du2 du3 The net energy outgoing is the sum ob energy entering & energy leaving is  $\iint dy = \partial (A, h_2 h_3 du_3) du,$ = 2 (A, h2 h3) duduz dus ( ( Å ds) = 2 (Azhhz) dur duz duz is 242 ( Azhhz) dur duz duz The conbribution prom all six baces of Avis [2 (Å hzhz) + 2 (Å h.hz + 2 (Å h.hz)] dur duz duz 242 243 JUNE 1964 Volume of parallelopiped is  $\Delta v = \int \int dv = h_1 h_2 h_3 du, du, du, du, du, & taking the limit$ as du, du, du, du, approach zero, we bind from equationV.A = ( Du, (Aihzhz)+ Duz (A chihz) + Duz (Ashihz) du, duz duz hihzbs du, dus dus

. VA = 1 [ ] (Ah2h3)+ ? (A2hih3) + ? (Ahih2) Hihahs [ ]u, (Ah2h3)+ ? (A2hih3) + ? (Ahiha) Juz This is the required of "For divergence of a vector bield Q.2 We know that div  $\vec{A} = \vec{\nabla} \cdot \vec{A} = \frac{1}{h_1h_2h_3} \begin{bmatrix} \partial (Ah_2h_3) + \partial (Ah_1h_3) + \partial (Ah_1h_2) \\ h_1h_2h_3 \end{bmatrix} \begin{bmatrix} \partial (Ah_2h_3) + \partial (Ah_1h_3) + \partial (Ah_1h_2) \\ \partial u_2 \end{bmatrix}$ AN F. F. where f is a scalar bield, substituting, let A 7. 7 F = V Familia = 1 2 (hishs (====) = 2 (hshi(====) + 2 (h, hz (=====)) h, hzhz 2u, (hishs (=====) + 2uz 2uz 2uz 2uz  $\nabla^2 f = 1$   $\frac{\partial}{\partial u_1}$   $\begin{pmatrix} h_2 h_3 & \partial f \\ h_1 & \partial u_2 \end{pmatrix} = \begin{pmatrix} h_1 h_3 & \partial f \\ h_2 & \partial u_3 \end{pmatrix} + \frac{\partial}{\partial u_3} \begin{pmatrix} h_1 h_2 & \partial f \\ h_3 & \partial u_3 \end{pmatrix}$ The haplacian operator 7<sup>2</sup> in orthogonal curvilinear co-ordinate is given by D<sup>2</sup>= 1 2 (haha 2) + 2 (hahi 2) + 2 (hiha 2) hihaha 2ui hi 2ui 2ua ha 2ua 2ua ha 2ua 0.3 let us consider \$ (4, 4, 4) a scalar bunction. The gradient of the Scalar bud \$ in the direction of 4, - axis can be Ans written gs  $grad \phi)_{u} = (\nabla \phi)_{u} = \lim_{\delta u, \to 0} \phi(B) \cdot \phi(A)$ 

where  $\phi(B) \notin \phi(A)$  are the values of scalar bundling  $\phi$  at  $B \notin K$  separated by distance  $AB = h_1 d_{14}$ . The quantity  $[\phi(B) - \phi(A)]$  may be taken as increase ind on travelling a distance  $AB = = h_1 d_{11}$ , this may be written as  $\partial \phi$  bor the limiting case where  $S_{4}$ ,  $\neq 6$  $\frac{\partial}{\partial u} \left( \frac{\partial}{\partial u} \right) = \left( \nabla \phi \right) u = \frac{\partial u}{\partial u} = \frac{\partial u}{\partial u} = \frac{\partial u}{\partial u} = \frac{\partial u}{\partial u}$  $(\nabla \phi)_{u_1} = 1 2\phi$ hi 2u\_1 Sinilarly, the component of gradient of  $\phi$  in the direct-ions les & us axes are (grad  $\phi$ ) in =  $(7\phi)_{42} = \frac{1}{h_2} \frac{2\phi}{2u_2}$  $\begin{cases} (grad \phi)_{43} = (\nabla \phi)_{43} = 1 & \partial \phi \\ h_3 & \partial u_3 \end{cases}$ Ib ú, úz, úz are unit vectors along the u, u, us directions respectively, then we can write.  $g_{\mu ad} \phi = \nabla \phi = \widehat{u_1} \partial \phi + \widehat{u_2} \partial \phi + \widehat{u_3} \partial \phi$   $h_1 \partial u_1 h_2 \partial u_2 h_3 \partial u_3$  $\overrightarrow{v} = \left( \begin{array}{ccc} \overrightarrow{u} & \overrightarrow{\sigma} & \overrightarrow{v} & \overrightarrow{\mu_2} & \overrightarrow{\sigma} & \overrightarrow{\mu_3} & \overrightarrow{\rho} \\ \hline h_1 & \overrightarrow{\sigma} & \overrightarrow{\mu_1} & & \overrightarrow{\mu_2} & & - h_3 & \overrightarrow{\sigma} \\ \end{array} \right) \begin{array}{c} \overrightarrow{\rho} \\ \overrightarrow{\rho} \end{array}$ It gives the del operator (7) in sethogonal curvilinear co-ordinates  $\overrightarrow{\nabla} = \overrightarrow{u} 2 + \overrightarrow{4z} 2 + \overrightarrow{u} 2$   $h_1 2u_1 \quad h_2 2u_2 \quad h_3 2u_3$ 

	।। ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।।
	- शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34052 Shri Swami Vivekanand Shikshan Sanstha Kolhapur's
	VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)
	SUPPLIMENT
	Suppliment No.: Roll No.: 8026 Class: B.SC-TH Subject: Mathematical physics Test/Tutorial No.: Div.:
	Class : D.SC-41 Div. :
Q.1	and the second of the second
Ans:	रिवकानंद जिन्
	the divergence of vector bunction may be obtained from gauss divergence theorem Gauss divergence theorem in vector analysis is given by
1	$\int \int (\nabla \cdot \vec{A}) dv = (\int \vec{A}) ds$
155	V
	where A = A, U, + A, U2 + A, U3
-	$div \vec{A} \iiint dv = \iint \vec{S} dS$
7.3. 3.2.	og div A = div S A ds dv + 0 SJ dv 40 + 0 SJ dv
The second	bet us bind direct component of JA de along 4, as,
	Frerqy entering through OBHC = - Athaha dua dua.
	Energy leaving through AKGI = A, h2h3 dur dus + 2 (A, h2h3) du, dus 24, (A, h2h3) du, du3

 $\left[\int A' ds\right] = \frac{\partial}{\partial u_1} \left(A, h_2 h_2 du_2 du_3\right) du_1$  $= \frac{\partial}{\partial u_{1}} \left( A_{1} h_{2} h_{3} \right) duy du_{2} du_{3}$  $= \frac{\partial}{\partial u_{1}} \left( A_{2} h_{3} h_{1} \right) duy du_{2} du_{3}$  $= \frac{\partial}{\partial u_{2}} \left( A_{2} h_{3} h_{1} \right) duy du_{2} du_{3}$ Ads = 2 (A3hih2) du, du, du Ju, (Ah2h3+2) (Athih3+2 (Ashih2) ] du, dus dus V = II dv = hihz hz du duzduz = [Ju, (A, h2h3) + Ju2 (A hih3) + Ju3 (A'hih2) duy dus dus h1 h2 h3 duy dus dus : VA = 1 2 (Aihzba) + 2 (Azhiha) + 2 (Azhiha) + 2 (Azhiha) hihaha 24, (Aihzba) + 2 (Azhiha) + 2 (Azhiha)

6.2 Ans We know that div À = Z Z = 1 (2 (Aihzhz) + 2 (Ashihz) + 2 (Ashihz) hihzhz (24, (Aihzhz) + 2 (Ashihz) + 2 (Ashihz) Zuz (Ashihz) let R = F.F.  $\operatorname{div} \vec{\Lambda} = \vec{\nabla} \cdot \vec{\nabla} F = \vec{\nabla}^2 F$  $\frac{1}{h_{1}h_{2}h_{3}} \left(\frac{1}{h_{2}h_{3}} \left(\overline{\nabla F}\right)_{u_{1}}\right) + \frac{2}{2} \left(\frac{1}{h_{2}h_{1}} \left(\overline{\nabla F}\right)_{u_{2}}\right) + \frac{2}{2} \left(\frac{1}{h_{1}h_{2}} \left(\overline$ 1 (hehs df) Au, h, du,) + 2 (hihs 2f) + 2 (hihz 2f auz hz auz) aug hz aug  $\nabla^2 f = 1$ hihzhz au, 242 h3h, 2 + 2 h2 Du2 243 V2= 2 (haha 2 ) do hihz h3 JUL 242 hipshaldy hi 0.3  $(grad \phi)_{u_1} = (\nabla \phi)_{u_1} = \lim_{\delta u_1 \to 0} \phi(B) - \phi(A)$ Ans: (grade) u = (vg) u = lins [ 5¢ Su, o [ h, du,  $(\nabla\phi)_{u_1} = 1$ 20 du 1964 lonomo

 $(grad \phi)_{u_2} = (\nabla \phi)_{u_1} = \frac{1}{h_2} \frac{2\phi}{2u_2}$ & (grad \phi)\_{u\_3} = (\nabla \phi)\_{u\_3} = \frac{1}{h\_3} \frac{2\phi}{2u\_2} ox  $\frac{\hat{U_1}}{h_1} \frac{\partial}{\partial u_1} + \frac{\hat{U_2}}{h_2} \frac{\partial}{\partial n_2} + \frac{\hat{U_3}}{h_3} \frac{\partial}{\partial u_3}$ 70 Ø  $\begin{array}{c} \overline{u_1} & \overline{\partial} + \overline{u_2} & \overline{\partial} + \overline{u_3} & \overline{\partial} \\ \overline{u_1} & \overline{\partial} + \overline{u_2} & \overline{\partial} + \overline{u_3} & \overline{\partial} \\ \overline{u_1} & \overline{\partial} \overline{u_1} & \overline{h_2} & \overline{\partial} \overline{u_2} & \overline{h_3} & \overline{\partial} \overline{u_1} \end{array}$ 2uz alesida 1

।) ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।। - शिक्षणमहबीं डॉ. बापूजी साळुंखे 34053 Shri Swami Vivekanand Shikshan Sanstha Kolhapur's VEKANAND COLLEGE, KOLHAPUR (AUTONOMO) SUPPLIMENT Signature of 9 Supervisor Subject: Math physics rement Suppliment No. 8019 Test / Tutorial No. : Roll No. BSC-III Class Div. : + 0.1 Gauss divergence divergence divergence Vector analysis is given by Ans+ be obtained Where Az II. A. I theorem box integrals By-the mean , up white Lits div 5 ds 08 div A ds JUNE Now consider the vehille plement V of inbinitesemal parallelopiped having edges 424

let us bind First component of [] A ds along u, as Energy endering Alwough OBHC = - Alhahadua du.3 Energy loaving through AKGJ = Achshadusdus + 2 (Achsha) duduedu  $\begin{bmatrix} \vec{j} \cdot \vec{l} & ds \end{bmatrix} = \frac{2}{U_1} (A_1 h_2 h_3 du_2 du_3) du_4$  $= \frac{9}{2U_1} (A_1 h_2 h_3) du_4 du_2 du_3$  $\frac{\left[\left[\frac{1}{2}\frac{1}{2}\frac{1}{2}\right]_{u_{1}}}{\frac{2}{2}\left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right)_{u_{2}}}\right] = \frac{2}{2}\left(\frac{1}{2}\frac{1}$  $\left[\frac{\partial}{\partial u_{1}}\left(\overline{A_{1}}h_{2}h_{3}\right)+\frac{\partial}{\partial u_{2}}\left(\overline{A_{2}}h_{1}h_{3}\right)+\frac{\partial}{\partial u_{3}}\left(\overline{A_{3}}h_{1}h_{2}\right)\right]du_{1}du_{2}du_{3}$   $Av = \left[\left(\int dv - h_{1}h_{2}h_{3}du_{1}du_{2}du_{3}\right)$ AV=SSS do= h.h.2 h. du, du, du  $\nabla \cdot A = \left[ \underbrace{\exists u}_{i} \left( A h_{2} h_{3} + \underbrace{\exists u}_{2} \left( A h_{i} h_{3} \right) + \underbrace{\exists u}_{3} \left( A h_{i} h_{2} \right) \right] du_{i} du_{3} du_{4} du_{3} du_{4} du_{3} du_{4} du_{3} du_{4} du_{3} du_{4} du_{$  $\nabla \overline{A} = \frac{1}{h_1h_2h_3} \begin{pmatrix} 2 \\ 2u_1 \end{pmatrix} \begin{pmatrix} \overline{A} \\ 2u_2 \end{pmatrix} + \frac{\partial}{\partial u_2} \begin{pmatrix} \overline{A} \\ 2u_3 \end{pmatrix} + \frac{\partial}{\partial u_3} \begin{pmatrix} \overline{A} \\ \overline{A}$ STESTD JUNE JUNE 1994

02 An: We know that  $\frac{div \vec{A} = \vec{r} \cdot \vec{A} = 1}{h_1 h_2 h_3} \begin{bmatrix} \vec{r} \cdot \vec{r}$ Let  $\vec{A} = \vec{\nabla} \cdot \vec{F}$ div  $\vec{A} = \vec{\nabla} \cdot \vec{\partial} F = \nabla^2 F$ . 2 (h2h3 (VF)) + 2 (h3h, (VF)) + 2 (h,hdv) = 1 hihaha hehz JF + 2 (hihz JF) + 2 (hihz JF) hi du, du h- duz dus (hz dus) D'F = L 204 hilishs 2 (hzhz 2) + 2 [hoh, 2] +2 (hchz. 2) 24, (h, 24) Duz (hz 24) Duz (hz 24) V2 = 1 hih2h3 Q.3. Ann: Let us consider \$ (4, 12, 13) a scalar bren . The greadent of the solar field \$ in the direction of 4, -axis can be Walten (9 read \$)u, = (\$\$)u = lim \$(B)-\$(A) : (gread \$) un = (\(\forall \) u\_1 = lim [S\$\$

( \ d) u = 1 30 similarly, the component of gradient of of in the directions is t Ularg (gead \$)un = ( x du = 1 20 hz duz ¢ (grad \$) us - (\(\forall \beta) us = 1 & 2\$\$ hs 2\$U3 U 2 + 42 7 + 43 2 4, 24 hz 242 hz 243 Zø : Or n o- adenates. (F) in arthogona It gives I  $\nabla' = u_1 \cdot 0 + u_1 \cdot 0 + u_3$  $h_1 \quad 2u_1 \quad h_2 \quad 2u_2 \quad h_3$ 2 243 A181-181A ٢ 17.30-٩

## Vivekananda College Kolhapur (Autonomous). Department of Physics: Internal examination 2019-20 B.Sc. III Semester V Subject: Quantum mechanics

Time : 20 min

[10]

## Q.1. Long Answer question (Attempt any ONE).

i) Obtain Schrodinger, s time independent equation and time dependent equation

ii) Explain quantum mechanical treatment of linear harmonic oscillator and show that zero point energy of oscillator is  $E 0 = \frac{1}{2} \hbar \omega$ 

## Q.2. Short Answer question (Attempt any TWO). [10]

i) Show that  $[x, Px] = i\hbar$  give its physical significance

ii) Give physical significance of wave function

Marks: 20 (Each question carry one mark)

J

iii) Obtain Schrodingers equation in spherical polar coordinate system for hydrogen atom



	विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।। – शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34056
	Vivekanand Shikshan Sanstha Kolhapur's
VIVEKANAND COLI	LEGE, KOLHAPUR (AUTONOMOUS)
SUPPLIMENT	Signature of Supervisor
Suppliment No. :	Subject: Quantym mechanics Test/Tutorial No.: Internal Exam
Roll No. : 8006 Class : BSC-TAI	Test/Tutorial No.: Internal Exam Div.:
A. TIME independent	Schrodinger's equation:
Schrodinger made	following Dassumptions:
AL O'L	length holds good for any particle
moving in a field	of force with potential energy (
The total encuris	aiven der alle
E E	KE + PE
	Carry 10
	2 00 00
5	कोल्हापूर
	2 m
	<u>c</u> +
·· E -	$\frac{P^{\star}}{2m}$ + V
$p^{2} = 2$	m(E-V) m(E-V)
:. p = [2	m(E-V)]"
	- the color - a
de - Broglie waveler	
de - Broglie waveler	$E_{2m}(E-v)J''^{2}$
	$L_{2}m(E-V)J_{m}$
	$L_{2}m(E-V)J_{1}L_{2}$
$\vec{x}$ The wave function $\Psi = \Psi_0$	L2m(E-V)]''2 hon (ψ) is given by, e-iwt2 college (artesian co-ordinate is to ESTD) μ + δ <sup>2</sup> ψ = 1 δ <sup>2</sup> ψ JUNE 2 <sup>2</sup> δz <sup>2</sup> μ <sup>2</sup> δt <sup>2</sup> Jutonomouto

Differentiating eqn (2) twice w.r.t. t,  $\frac{\partial^2 \varphi}{\partial t^2} = -w^2 \varphi e^{-i\omega t} = -w^2 \varphi$ Substituting above in eqn (3),  $\frac{\partial^2 \psi}{\partial t^2} + \frac{\partial^2 \psi}{\partial t^2} + \frac{\partial^2 \psi}{\partial z^2} = -\frac{\omega^2 \psi}{u^2}$ Here,  $\omega^{\perp} = (2\pi p)^{\perp} = 4\pi^2$  &  $\partial^2 \psi + \partial^2 \psi + \partial^2 \psi = \nabla^2 \psi$  $u^2 (\pi \lambda)^2 = \chi^2 = \partial^2 \psi + \partial^2 \psi + \partial^2 \psi = \nabla^2 \psi$  $\therefore \forall \varphi = -4\pi^2 \varphi$  $\frac{1}{2^2} \nabla^2 \Psi + 4 \pi^2 \Psi = 0$ (4) द्वकानंब हो This eqn is general time-independent eqn. By the concept of wave mechanics, de-Broglie wavelength is Em(E-VDuz Substituting this is eqn (G),  $\nabla^2 \varphi \neq 4T^2 [2m(E-v)] \varphi = 0$   $h^2$  $\nabla^2 \varphi = 8m \Pi^2 (E - V) \varphi = 0$ : th = h  $\frac{1}{(t^2)} \frac{(t^2)}{(t^2)} \frac{(t^2)}{(t^2)}$ Eq" (5) represents Scheedinger's time-independent wave eqn

B. Time-dependent schrodinger's eqn: We have,  $\Psi = \Psi_0 e^{-iwt}$ :. 24 = - iw loe-iwt = - i (2TT 2) Q  $= -i(2\pi)(E)\psi$ ·: ~= E ·. EY - 1 (h) 24  $E \psi = i t \partial \psi$ C From  $eq^n(5)$ ,  $\nabla^2 \psi + 2mga dEl$  $\frac{2m}{\ln^2}$   $v(\psi) = C$ 1 2 1 J Substituting eq" (B), VY=O 2m  $\nabla^2 \varphi + 2m (i \partial \varphi)$   $\overline{h} \partial t$ 1070 + it 24 Dt th2) 724  $\frac{1}{2} \frac{1}{2} \frac{1}$ 2m Schoodinger's time - dependent represents 9 eq". ) Ja Ja ind 1. THE STREET 1 the au UNF 111 Set 1

9.2. Ans. Consider the action of commutator [7, Pn] on wave Function ((n),  $[x, p_n] \varphi = [x, -ih \partial. ] \varphi$ = -it9 [RG R]  $= -i\hbar \left[ x \partial \psi - \partial (x \psi) \right]$ -it [ n 24 - n 24 - 4] = -it (- 4) [x, Pm] 4 = it & since a (r, pr] = it Q.3. Due to interpretation of 1412 cer probability density, the wave function (4) must obey: Ans. i) q'must be finite for all values of x, y & z. i) & must be single-valued i.e. for each set of n, y & z, 4 mut be only one valued. (ii) 4 must be continuous in all regions, except in those regions where the potential energy  $V(x, y, z) = \infty$ . iv) 4 must wall vanish at Infinity. : q=0 at x> too/y> too / z> too. The potential derivatives of 4 1.e. 24, 24, 24 Dr. 04, 02 must also be infinite, single-valued & continuous at all points, except at points where the potential is V(x,y,z) is infinite.

SUDDIIMENT	Signature
SUPPLIMENT 20	of Supervisor
Suppliment No. :	subject: guantym mechanics
Roll No. : 8015	Test / Tutorial No. :
Class : BST - HI	Div. :
->IT i me independent	Schrodigers apiction:
Schrodinger made	
@ He assumed that	des Broglie wavelength holds goo
for any particle most	18/ CALLER A
	ergy is orven be.
E = KE	and a strend of
	W2 W 2000 5
00 2	Dia One
= ].	markatt
2	
.: F = F	p <sup>2</sup> V
	m
$P^2 = 24m$	E-V)
	E-V)]"
ST T	
· de-Broglie wandengt	f(x) = h = h
a vidgite wavering	P [2mCE-V)]"2
(b) He assumed that the	
10 He assumed that the	e wave function (4) is goven by

T

The wave eqn in Cartesian car co-ordinate is,  

$$\frac{2^{2} (0)}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} = \frac{1}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} = \frac{1}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} = \frac{1}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} = \frac{1}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} = \frac{1}{2\pi^{2}} + \frac{2^{2} (p)}{2\pi^{2}} + \frac{2^{2} (p)}{$$

Eqn 3 represents Schrodinger's time-independent wave of I) Time-dependent Schrodinger's eqn: We have,  $p = p_0 e^{-i \omega t}$  $\frac{\partial \varphi}{\partial t} = -i\omega \varphi_0 e^{-i\omega t}$ - i(2m2) p -: (217) (E) p "," V = E h EY  $\frac{1}{24} \left( \frac{1}{24} \right) \frac{\partial \varphi}{\partial t}$  $e \varphi = i t_{i}$ :.. ·· +==.h. 16 from eqn O, 200 2m NQ 93 0 Substituting eq" (a), anony 20 3t  $\frac{1}{2} \nabla^2 \varphi + 2m ; \partial \varphi - 2m v \varphi = 0$   $\frac{1}{2} \partial t + \frac{1}{2} \frac{1}{2$ : (t2) 024  $+ : h \partial \varphi = 0$ ri man  $-\frac{(t^2)}{(2m)}\nabla^2\psi + \nabla\psi$ it au at 120 time - depende 7) represent Schrodinger's 3,43.4. 

BR.2 > Consider the action of commutation [21, Pu] on wave function ( 2)  $[x, P_n] \Psi = [x, -it \partial] \Psi$ = J-it [n. 2]4 = -it (x 24 - 2 (ny))  $= -it \left[ \frac{x}{2} \frac{\varphi \varphi}{\varphi} - \frac{y}{2} \frac{\varphi}{\varphi} - \frac{\varphi}{2} \right]$  $= -ith(-\varphi)$  $[n, P_n] \varphi = i t \varphi$ [N, Pn] = it anni in Q.3. Due to interpretaction of 1612 as probability density, the wave function & must abey the following conditions: De must be finite all for cell values of r.y & Z @ 4 must be single-valued to for each set of n, y & z must have only one value of P. 3 9 must be continuous in all regions, except in those Equins where the potential energy V(n, y, z) Equinet vanish at infinity is sie l=0 au x = 2 toof y= 2 too / z=> too The particel derivatives of Use. 24, 24, 7 an org 24 24 must also be finite, single-valued & and continuous cet cel points, excepts at points where the potenticel V(x) is infinite.

	कार यांसाठी शिक्षण प्रसार ।। – शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34054 Shikshan Sanstha Kolhapur's
and the second se	KOLHAPUR (AUTONOMOUS)
SUPPLIMENT	Signature of Supervisor
Suppliment No. : 20	Subject: Quantum mechanics
Class : BSL-TJL	Div. :
8.1.	
-> I: Time independent Se Schrodinger der	
of matter waves. Hence	e -Broglie wavelength holds
good for any particle	maving in a field of force
E = KE + P	J, J, J, J,
$E = \int mv^2$	
$= \frac{1 - m^2 v^2}{2}$	
$= 1 \frac{p^2}{2m}$	+V A
$p^2 = 2m($	CE-V)
$\therefore p = (2m)$	E-V07'2
de-Broglie wavelength	$(\lambda) = h = h$
	P (2m(F-V)(* ESTD) JUNE + 1964 \$
	Autonomous

Det dessumed that the wave funct (4) is governed by ,  $\Psi = \Psi_0 e^{-i\omega t}$ -(2) The usual wave eq" is cortesion co-ordinates is,  $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = \frac{1}{2^2} \frac{\partial^2 \psi}{\partial t^2} = \frac{1}{2} \frac{\partial^2 \psi}{\partial t^2} = \frac{1}{2$ Differentiating D'wird time,  $\frac{\partial^2 \psi}{\partial t^2} = -\omega^2 \psi_0 e^{-i\omega t} = -\omega^2 \psi$ Substituting this (eqn (B),  $\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial$ Where,  $\omega^{2} = (2\pi)^{2} = 24\pi^{2}$  $u^{2} = (2\pi)^{2} = 24\pi^{2}$  $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} = -\frac{4\pi^2}{\chi^2} \psi$  $A^{2} \nabla^{2} \psi + 4\Pi^{2} \psi = 0$ 4 Eqn ( is general eqn & is independent of time By the concept of wave mechanics, de-Brocher wavelength,  $\lambda = h = h$ P [2m(E-V)]''2

1

	Substituting this in eqn (4),
į,	$\nabla^2 \Psi + (r \Pi^2 [2m (E - v)] \Psi = 0)$
	h2 tonice of the
	$\nabla^2 \Psi + \left(\frac{8m\pi^2}{\mu^2}\right) \left(\frac{E-\nu}{\Psi}\right) \Psi = 0$
	Also, the h
	241
	$:: \nabla^2 \Psi + (2m) (E - V) \Psi = 0 - \overline{S}$
	$\frac{\nabla^2 \psi + (2m)(E-V) \psi = 0}{\pi^2} - \overline{S}$
	ean Brepresents Schrodinger's time - independent
	wave eq". Satisfier State - indepition
	E Carlos Carlos
(L	II. Time-dependent Schrödinger's eqn:
ę.	
	y = y etile second b
0	$i \partial \Psi = -i \omega \partial \Psi = -i \omega t$
V O	$i \partial \psi = -i\omega \partial \psi = -i\omega t$ $\partial t = -i\omega \partial \psi = -i\omega t$
1	$= -i(2\pi 2)\psi$
	A start and an Let will be the
/	$= -i(2\pi)/\epsilon \gamma \Psi$
	h (h) h
Y"	$E\Psi = -1 (h) au$
	$E = -1 (h) \partial \psi$ $i (2\pi) \partial t$
En.	$E\Psi = i\hbar \partial \Psi$ [:: $\hbar = h & i^2 = -1] - 6$
	at l'at
Tar)	from, eq? (5), $\nabla^2 \psi + 2m E \psi - 2m V \psi = 0$ (0)
4	$t^2$ $t^2$ $t^2$ $t^2$ $t^2$ $t^2$ $t^2$ $t^2$
1	
	7 1964 - 07 (7) (7) (7) (7) (7) (7) (7) (7) (7) (7)

.

 $-\left(\frac{2m}{t^2}\right)V\psi = 0$  $\frac{\partial^2 \psi + 2m; \partial \psi - 2m}{\hbar \partial t} \quad \frac{\nabla \psi = 0}{\hbar^2}$  $\frac{1}{2m} \frac{(h^2)}{(2m)} \frac{\nabla^2 \psi}{\psi} + \frac{(h^2)}{(2m)} \frac{\psi}{\partial t} - \frac{\nabla \psi}{\psi} = 0$  $\frac{\partial t}{\partial t} = t - \frac{d^2}{2m} \frac{d^2 \psi}{d^2 \psi} + \frac{d^2 \psi}{d^2 \psi} +$ 7  $\therefore E \Psi = H \Psi$ Where, [-h2 D2 + V] - Hamiltonian 12 This Eq" (8), represents the motion of non-relavistic Eqn D represents Schrödinger's time-tependent edin काल्हापूर 8.2. (onsider [x, Px] on wave funce  $\Psi(x, y, z)$ ,  $[x, Px]\Psi = [x, -ita]\Psi = -ita[x a]\Psi$ ->  $= -i\hbar \left[ x \partial - \partial x \right] \psi$ =-it [ x du - d (xy)]  $= -it(-\psi)$  $= -it(-\psi)$   $= it(\psi)$ JUNE 1964  $\therefore [x, p_x] = ih$