"Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe
Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

B.Sc. Part-III SEM V Examination (2023-24)
Mathematical Physics

Date : Total Marks: 15
Day : 12.00 to 1.00 pm Time :-

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) Select correct alternative **(3)**

1. The 'i' in complex number is represented by--------.

(a) 1 (b) -1

(c) $\sqrt{1}$ (d) $\sqrt{-2}$

2. If f(z) is analytic and its derivative is continuous at all points inside and an simple closed curve C, then $\int_c f(z)dz =$ --------.

(a) 0 (b) π

(c) 2π (d) ∞

3. A point at which function f(z) is not analytic is known as ---------

(a) singular point (b) analytic point

(c) isolated point (d) removable point

Q.2 Attempt any THREE **(12)**

1. Derive the necessary condition for function f(z) to be analytic in given region R.
2. Evaluate $\int_c \frac{e^z}{z^2+1} dz \; ; |z| = 2$
3. Discuss the analyticity of the function $f(z)=z^3$
4. Evaluate $\int_c \frac{z+4}{z^2+2z+5} dz$ over the circle $|z + 1| = 1$

Internal Attendance
Mathematical Physics
B.Sc-III
25 oct 2023

Roll No.	Name	Sign
8205	Sushant Vilas Sutar	Sutar
8202	Rushi Chandrakant Dongare	
8203	Shrutika Sambhaji Phot	Shrutika
8204	Shreyashree Shantinath Demmana	Demmana
8201	Misam Ashfak Pathan	Ypathan

VIVEKANAND ... KOLHAPUR ESTD JUNE 1964 (Empowered Autonomous)

Date : 24/09/2024

Gaurav Ajit Dadarne

" ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार "
-शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

10/15

SUPPLIMENT

Signature of Supervisor	
Suppliment No. : 1	Subject : Mathematical Physics
Roll No. : 8202	Test / Tutorial No. : SEM V Internal Exam
Class : B.Sc TY	Div. :

Q 1

1] The i in complex number is represented by

→ c] $\sqrt{-1}$

2] If f(z) is analytic and its derivative is continuous to all points inside curve C, then $\int_C f(z)\,dz =$

→ a] 0

3] A point at which function f(z) is not analytic is known as

→ a] singular point

03

VIVEKANAND COLLEGE KOLHAPUR (An Autonomous) ESTD JUNE 1964 Empowered

Q 2

3]

→ $f(z) = u + iv$

ex z^2 = ex = $(x^3 + iy)^3$

$z^3 = x^3 - 3x^3iy$ + $3x^3(iy)^2 + (iy)^3$

$x^3 - 3x^3iy$ − $3x^3iy - 3xiy^3$

$x^3 - 3x^3iy$ = $3x^3iy - xiy$

$x^3 = 3x^3iy$ + $(3x^3iy - y^3)$

$u = 3x^3iy$.

$v = 3x^3iy - y^3$

(1) $\frac{\partial u}{\partial x}$ $3x^2 - 3y^2$

(2) $\frac{\partial v}{\partial y} = -6xy$

(3) $\frac{\partial v}{\partial x} = -6xy$

(4) $\frac{\partial u}{\partial y} = 3x^2 - 3y^2$

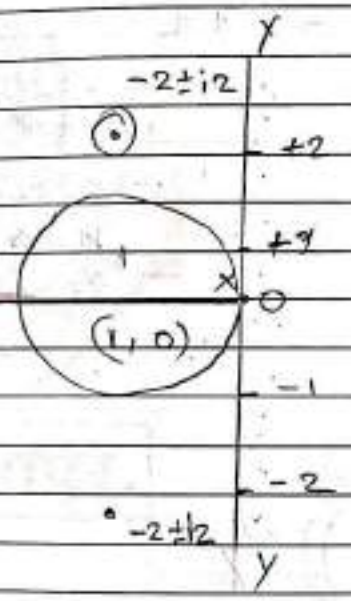
4]

→ polar at given by denominator is equal to zero

$$z^2 + 2z + 5 = 0$$

$$= \frac{-2 \pm \sqrt{4-20}}{2} \qquad \frac{-2 \pm i4}{2}$$

$$= -2 \pm i2$$



The circle $|z+1| = 1$ and its center is $z = -1$ and the Radius $\oint_C \frac{2+4i}{z^2+z^2+5} dz = 0$

Dose Not enclose an analytict function

2] ⇒ $\int_C \frac{e^z}{z^2+1} dz : |z| = 2$

$\therefore z^2 + 1 = 0$

$z^2 = -1$

$z^2 = iz$

$z^2 = \pm i$

$z_1 = +i$

$x + iy = +i$

$x = 0$

$y = +1$

$z_2 = -i$

$x + iy = -i$

$x = 0$

$y = -1$

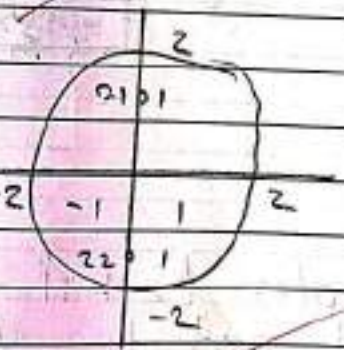
$|z| = 2$

$|z - z_0| = r$

$r = 2$

$x = 0$

$y = 0$



$= \frac{\int e^z}{e^z + 1} dz = \int_C e^z \left\{ \left(\frac{1}{2i}\right) \frac{1}{z+i} + \frac{-1}{2-i} \right\}$

$\left(= \frac{1}{2i}\right) \int_C \frac{e^z}{z+i} dz + \frac{1}{2i} \int_C \frac{e^z}{z-i} dz$

$= -\frac{1}{2} [2\pi i \cdot e^{-i}] + \frac{1}{2i} [2\pi i e^{i}]$

$\Rightarrow = \pi e^{-i} - \pi e^{i}$

$= \pi \left(e^{i} - e^{-i}\right)$

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

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 1
Roll No. : 8202
Class : B.SCTY

Subject : Mathematical physics
Test / Tutorial No. : SEM V Internal Exm
Div. :

1]

→ $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$; $\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$

let f(z) be an analytic function of u and v where u and v are function of x and y respespoding impliment in ∂x and ∂y in x and y.

$f(z) = u - iv$

$F(z - dz) = u + \delta u + iv + i\delta v$

$f(z - \delta) = f(z) = u + \delta u + iv + \delta v - y\, iv$

$= \delta u + i\delta v$

$z = x + iy$

$\delta z = \delta x + i\delta y$

$= \frac{\delta f(z)}{\delta z} \quad \lim_{\delta z \to 0} \left[\frac{\delta u}{\delta z} + \frac{i\delta v}{\delta z} \right]$ —1

$\left[\frac{\delta u}{\delta z} + \frac{i\delta v}{\delta y} \right]$ —(1)

Along real axis :

$\delta y = 0$, $\delta z = \delta x$

$$\frac{\delta f(z)}{\delta z} \quad \frac{\lim}{\delta x \to 0} \quad \frac{\delta u}{\delta x} + \frac{i \delta v}{\delta x}$$

$$\frac{\delta u}{\delta x} + \frac{i \delta v}{\delta x} \quad \text{---} \quad \text{II}$$

24-09-2024

Ritesh shelekar sawlekar

"ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार"
-शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOU

3/15

SUPPLIMENT

Signature of Supervisor	
Suppliment No. :	Subject : mathematics/phy
Roll No. : 5210	Test / Tutorial No. :
Class : BSc-III	Div. : BSC - III

Q.1

1) $c\sqrt{-1}$ ✓ 1

2) (a) 0 ✓ 1

3) (a) singular point. ✓ 1

03

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Q2)

i) $\Rightarrow \frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$; $\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$

Let $f(z)$ be an analytic function of u & v

$f(z) = u + iv$

where u & v are function of x & y respectively

corresponding increment in x & y is δx & δy

$\therefore f(z) = u + iv$

$f(z + \delta z) = u + \delta u + i v + i \delta v$

$f(z + \delta z) - f(z) = u + \delta u + iv + i\delta v - u - iv$

$= \delta u + i \delta v$

$\therefore z = x + iy$

$\delta z = \delta x + i \delta y$

$= \frac{\delta f(z)}{\delta z} = \lim_{\delta z \to 0} \left[\frac{\delta u}{\delta z} + i \frac{\delta v}{\delta z} \right]$ ——— (1)

$\left[\frac{\delta u}{\delta z} + i \frac{\delta v}{\delta z} \right]$ ——— (2)

along real axis $\delta y = 0$

$\delta z = \delta x$

$\frac{\delta f(z)}{\delta z} = \lim_{\delta x \to 0} \frac{\delta u}{\delta x} + i \frac{\delta v}{\delta x}$

$\frac{\delta u}{\delta x} + i \frac{\delta v}{\delta x}$ ——— (3)

along imaginary axis

$\Delta x = 0$, $\Delta z = i\Delta y$

$$\frac{df(z)}{dz} = \lim_{i\Delta y} \left[\frac{\Delta u}{i\Delta y} + i\frac{\Delta v}{i\Delta y} \right]$$

$$\frac{\partial v}{\partial y} = i\frac{\partial u}{\partial y} \quad \text{---} \quad \text{(III)}$$

Since given eqn is analytic derivative at both direction is same. (II) & (III)

$$\frac{\partial u}{\partial x} + i\frac{\partial v}{\partial x} \quad , \quad \frac{\partial v}{\partial y} = -i\frac{\partial u}{\partial y}$$

Substituting in (II) & (III)

we get.

$$\boxed{\frac{\partial u}{\partial x} + i\frac{\partial v}{\partial y} \quad , \quad \frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}}$$

2) $\Rightarrow \oint_C \frac{e^z}{z^2+1}\,dz \; ; \; |z| = 2$

$\therefore z^2 + 1 = 0$

$z^2 = -1$

$z^2 = i^2$

$z^2 = \pm i$

$z_1 = +i$

$x + iy = +i$

$x = 0$

$y = +1$

$z_2 = -i$

$x + iy = -i$

$x = 0$

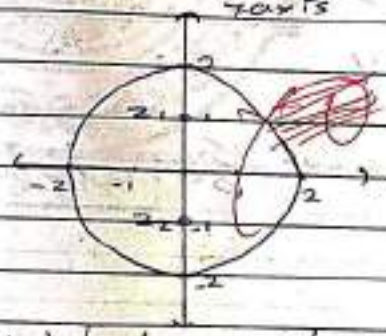
$y = -1$

$|z| = 2$

$|z - z_0| = r \quad , r = 2$

$x = 0$

$y = 0$



Draw Contour by Cauchy

$$= \oint_C \frac{e^z}{z^2+1}\,dz = \oint_C e^z \left(\frac{1}{2i}\right)\left[\frac{1}{z+i} + \frac{1}{z-i}\right]$$

$$\left(\frac{-1}{2i}\right)\oint_C \frac{e^z}{z+i}\,dz + \frac{1}{2i}\oint_C \frac{e^z}{z-i}\,dz$$

$$= -\frac{1}{2i}\left[2\pi i\, e^{-i}\right] + \frac{1}{2i}\left[2\pi i\, e^{i}\right]$$

$$= -\pi e^{-i} + \pi e^{i}$$

$$\Rightarrow \pi\left(e^{i} - e^{-i}\right)$$

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

SUPPLIMENT

Signature of Supervisor	

Suppliment No. : 01
Roll No. :
Class :

Subject :
Test / Tutorial No. :
Div. :

3) $f(z) = z^3$

$\Rightarrow z^3 = (x+iy)^3$

$= x^3 + 3x^2iy + 3x(iy)^2 + (iy)^3$

$= x^3 + 3x^2iy - 3xy^2 - y^3 i$

$= x^3 - 3xy^2 + i(3x^2y - y^3)$

$u = x^3 - 3xy^2$

$v = 3x^2y - y^3$ — 01

$\frac{du}{dx} = 3x^2 - 3y^2$ $\quad \frac{\partial u}{\partial y} = -6xy$

$\frac{dv}{dx} = 6xy$ $\quad \frac{\partial v}{\partial y} = 3x^2 - 3y^2$

$\therefore$ Hence, $f(z)$ is an analytical function

4) $\int_C \frac{z+4}{z^2+2z+5} dz$ $|z+1|=1$

$\Rightarrow z^2+2z+5=0$

$$\frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$= \frac{-2 \pm \sqrt{4-20}}{2}$$

$$= \frac{-2 \pm \sqrt{16}}{2}$$

$$= -1 \pm 4i$$

$z_1 = -1+4i$ $\quad z_2 = -1-4i$

$x+iy = -1+4i$ $\quad x+iy = -1-4i$

$x = -1$ $\quad x = -1$

$y = +2$ $\quad y = +2$

$+$

$|z+1|=1$

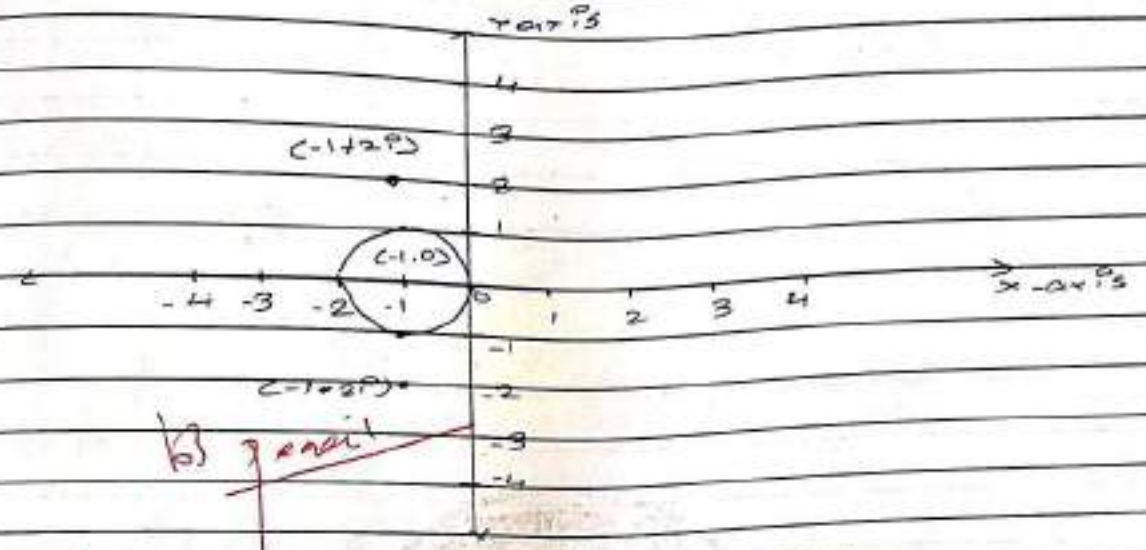
$z_0 = -1, r = 1$ $\quad x+iy = -1$

$x = -1$

$y = 0$

The $|z+1|=1$ is over the circle on it is on $z_0 = -1$. The radius unity does not enclose on singularity $\frac{z+4}{z^2+2z+5}$.

$$\int_C \frac{z+4}{z^2+2z+5} = 0$$



b) pencil

" ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार "
-शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOI

13/15

SUPPLIMENT

Signature of Supervisor

Suppliment No. :

Roll No. : 8441

Class : Physics (T.Y)

Subject : Mathematical Physics.

Test / Tutorial No.: Unit Test Internal Exam

Div. :

Q1) select the correct alternative

(1)

→ c] $\sqrt{-1}$. 1

(2)

→ a] 0. 1

(3)

→ a] Singular point. 1

03

Q2]

2] Evaluate $\int_C \frac{e^z}{z^2+1} dz$; $|z|=2$.

→ $z^2+1 = 0$

$z^2 = -1$

$z^2 = i^2$

$z = \pm 1$.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

z_1 | z_2 | $|z-2| = r$

$x+iy=1$ | $x+iy=-1$ | $c-2=0$

$x=0$ | $x=0$ | $x=0$

$y=1$ | $y=-1$ | $y=0$

$r=2$.

$$\therefore \int_C \frac{e^z}{z^2+1}\,dz = \int_C e^z\left[\left(\frac{-1}{2i}\right)\left(\frac{1}{z+i}\right) - \left(\frac{1}{z-i}\right)\right]$$

$$= \frac{-1}{2i}\int_C \frac{e^z\,dz}{z+i} + \frac{1}{2i}\int_C \frac{e^z}{z-i}\,dz$$

$$= \frac{-1}{2i}\left(2\pi e^{i}\right) + \frac{1}{2i}\left(2\pi e^{-i}\right)$$

$$= \frac{-\pi}{i}\left(e^{i} + e^{+i}\right)$$

$$= \pi\left(e^{i} - e^{-i}\right)$$

Q3] $f(z) = z^3$ $\quad f(x) = x+yi$

$f(z) = x+yi$ $\quad f(z) = u+vi$.

$$z = (x+yi)^3$$
$$= x^3 + 3x^2yi + 3i^2xy^2 + i^3y^3$$
$$= x^3 + 3x^2yi + 3(-1)xy^2 + yi^3$$
$$= x^3 + 3x^2yi - 3xy^2 - yi^3$$
$$= x^3 + 3x^2yi - 3xy^2 - y^3 i$$
$$= x^3 - 3xy^2 + (3x^2y - y^3)i$$

$\therefore$ $u = x^3 - 3xy^2$

$v = 3x^2 - y - y^3$

$\therefore \frac{\partial u}{\partial x} = 3x^2 - 3y^2$ $\qquad \frac{\partial u}{\partial y} = -6xy$

$\therefore \frac{\partial v}{\partial x} = 6xy$ $\qquad \frac{\partial v}{\partial y} = 3x^2 - 3y^2$

03] $\therefore \frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$.

04] $\int_C \frac{z+4}{z^2+2z+5}\,dz$ $\qquad |z+1| = 1$.

→

z^2+2z+5

$1z^2+2z+5$

az^2+2b+c $\qquad \therefore a=1 \quad b=2$ and $c=5$.

$\therefore z = \frac{-b \pm \sqrt{b^2-ac}}{2a}$

$z = \frac{-2 \pm \sqrt{4-(1)(5)}}{2}$

$= \frac{-2 \pm \sqrt{-1 \times 16}}{2}$ $\qquad \sqrt{-1} = i$

$= \frac{-2 \pm 4i}{2}$

$= \frac{2(-1 \pm 2i)}{2}$

$= (-1+2i)$

$\therefore z = (-1+2i)$ $\qquad \therefore z = (-1-2i)$

Given as $|z+1| = 1$ at the radius centre at $z = -1$ does not encloses singularity function $\frac{z+4}{z^2+2z+5}$.

$\therefore \int_C \frac{z+4}{z^2+2z+5}\,dz = 0.$

$$\int_C \frac{z+4}{z^2+2z+5}\,dz = \int_C \frac{z+4}{[z-(-1+2i)][z-(-1-2i)]}\,dz$$

$$= \int_C \frac{\frac{z+4}{z-(-1+2i)}}{z-(-1-2i)}\,dz$$

$$= 2\pi i\, f(-1-2i)$$

$$= 2\pi i \left(\frac{3-2i}{4}\right)$$

$$= \pi i \left(\frac{3-2i}{2}\right)$$

$$= \frac{\pi}{2}(2i-3).$$

— x — x —

Internal Attendance
Nuclear & particle Physics
B.Sc. III
25 oct 2023

Roll No.	Name	Sign.
8205	Sushant Vilas Sutar	
8201	Shreyashree Shantinath Demanna.	
8203	Shruthika Sambhaji Khot	
8202	Rushi Chandrakant Dongare	
8204	Misam Ashfak Pathan	

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous)
ESTD JUNE 1964

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥

– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51767

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	

Suppliment No. :

Roll No. : 8210

Class : B.Sc-II

Subject : Nuclear & particle Phy.

Test / Tutorial No. : I. Exam

Div. :

19/15

Q.1 A)

1) c) Nucleons

2) a) short range force.

3) c) A-2

VIVEKANAND COLLEGE KOLHAPUR (AUTONOMOUS) ESTD JUNE 1964 Empowered - Conferred

Q 2)

3) Liquid drop model

1) The liquid drop model was 1st proposed by Niel's Bohr in 193
2) These model make comparison bet nucleus of an atom and drop of
3) Nucleus is very small quantum particles.
4) These is centre core of an atom
5) The drop of liquid is microscopic collection for a molecules.
6) By assuming nucleus to behave li a drop of liquid we can make ver accurate probability as same as properties of nucleus.

I) The similarity of nucleus & drop of liquid is given below: —

i) Both nucleus & drop of liquid co contain large neat particles.
ii) Both nucleus & drop of liquid ar homogeneous & incompressible.
iii) The nuclear mass density constant Throughout it's entire volume. & drop of zero near it's boundary surface just like a drop of liquid
iv) In nucleus, nucleons interact with strongly only neighbouring nucleon This similar to drop of liquid in molecules is interacts with their closed neighbouring molecule's particle.

vi) Both nucleus & drop of liquid is shows surface tension effects.

vii) Binding energy of nucleus is analogous to heat of vaporization of liquid.

viii) This similare to related a fission & fusion. when you have two drop of liquid & they merge together form a large liquid drop. when you have large liquid drop and the break and get seperated into two small liquid drop. This is very much similar to nucleus of nuclear reaction fission.

8) with this analogies, nuclear is as compared to drop of liquid and hence liquid drop model for nucleus

9) This model make to used to explain the certain nuclear proces like nuleers fission. It can be used to obtained an expression of nuclear mass. this calculated mass of any nuclied. Therefore, the calculated nucleus is called constant.

4) (a) magic numbers

1) The observation of B.E curves of few nuclei gives a smooth curve.
2) These peaks indicated as most elements are abnormally more stable than compare to other elements.
3) The calculation B.E and study of abundance of elements in nature is shows certain elements are more stable.
4) All the observation of neutron neutron energy depends on the nuclei having no of protons & neutrons equally in 2, 8, 20, 28, 50, 82 & 126 is particular most stable.
5) This series of no. is referred as magic no.

As a evidence for magic no is obtained to measuring the percentage of abundance for e.g.

$^{16}_{8}O$ $^{208}_{82}Pb$ $^{100}_{50}Sn$ (Z=N=50) etc

are most stable abundant in nature & Lead as also 2 is value of magic no. The these elements have longer no of isotope.

for ex. $^{16}_{8}O$ $^{17}_{8}O$ $^{18}_{8}O$ 2:8 magic no.

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51772

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. :

Roll No. :

Class :

Subject :

Test / Tutorial No. :

Div. :

- and also strontium (Sr) have 10 isotopes.

- The nutrons is N(A-Z) is magic no. then they have large no. of isotones.

For eg. maximum no. of isoton occur for N = (A-Z) = 50 & 82

N = 50, above 50.6 elements namely,

Kr Krypton = 86
Ytrium = 89
Zirconium = 90
Molybdenum = 92
Radium = 88

- The Z & N value belongs to magic no. they They have most stable elements

For ex.

$^{16}_{8}O$ $^{40}_{20}Ca$ $^{4}_{2}He$ - all are magic no.

3)

1) This is centre core of an atom is called a nucleus. contain 2 types no N=(A-Z) neutron. A is mass no and Z is atomic no.

2) The atomic no. of an elements is determined by no. of protons in it. It is used to one element to another.

3) The mass no. of an elements is determined by no. of protons & neutrons is commonly.

4) The natural occurrences of neutrons. (Proton + neutrons) are believed

Q) charge :-

i) proton are positively charge. having one electronic unit charge. (1.6×10^{-19} C) called a numerically equal to charge on electron.

ii) mass :- Both are contain almost equal masses.

iii) Same in each

charge :- 2nd point - neutrons is electrically neutral particle.

e 25/9/2024

(v) Nuclear Binding forces:

The all nucleus held together by nucleus by strong short range attractive force is called a nuclear forces. The forces are neutron - neutron, neutron - proton, proton - proton. are also equal.

(vi) Spin Angular momentum

nucleons are fermi fermion angular moment of $\frac{\hbar}{2}$

The obey fermi - Dirac statistics & pauli's exclusion principles

(vi) magnetic moments:

The spinning charge is rise to magnetic moments

The proton poless the magnetic moments of $\mu_p = 2.793\ \mu_N$ where μ_N is nuclear magnetic moments of $\mu_n = -1.913\ \mu_N$.

The magnetic moments of nuclear nucleus is determined by rotating negative charge particle.

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51768

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. :
Roll No. : 8202
Class : B.Sc TY

Subject : Nuclear and Particle Physics
Test / Tutorial No. : SEM V Internal Exam
Div. G

Q 1

A]

1] The nucleus of an atom consists of

⇒ d] ~~protons, electrons and neutrons~~

⇒ c] Nucleons

2] Nuclear forces are

⇒ a] short range force

3] The number of neutrons in an atom of atomic number Z and mass number A is

⇒ c] A-Z

Q2

2]

→ liquid drop model for a nucleus.

1] The ~~Hig~~ liquid drop model 1st proposed by Niel's Bohr in 1937.

2] The liquid drop model comprises between Nucleus of ~~and~~ an atom, and liquid drop.

3] The Nucleus is the ~~core of an~~ Center ~~of~~ core of an atom.

4] The Nucleus is a ~~very~~ very small gauntam partical.

5] Nucleus is made up of tine molecules like liquid drop

6] We can assume the very ~~per~~ Perfect prédection of nucleus properties by liquid drop model.

7] The simplistdy condition of liquid drop and nucleus.

i] The nucleus is group of molecules like liquid drop

ii] The nucleus and liquid drop is homogeneos and ~~icomp imp~~ icompressable.

iii] Nucleus is heated heat by vaporization like liquid drop

iv] liquid drop model for a nucleus is fission and ~~fusion~~ fusion.

v] A Nucleus, Nucleus interacts ~~is~~ very strongly with it neighboring elements.

vi] A Nucleus has proton and nutron in it nature.

4] Magic numbers.

→ 1] The observation of B.E curve shows smooth peaks it is a very stable element.

2] The indecator that same elements are more stable as compared to thire neighbbring elements

3] The calculation of the B.E and the staby of abaundance of element in nature shows that some elements are more stable.

4] When no of protons or electrons of elements are equal to 2, 8, 20, 28, 50 and 126 then those elements are more stable.

5] This number of series is refered as magic numbers

As number of evidences for magic numbers obtained by measuring the perenctage of abundance. for eg:

$^{16}_{8}O$ (Z=8, N=8) $^{120}_{50}Sn$ (Z=50) etc.

These elements are more abundant in nature, Hence they are more stable.

If the value of Z is a magic number then those elements have large number of isotopes for eg:- $^{16}_{8}O$ $^{17}_{8}O$ $^{18}_{8}O$, Z=8 and 8 is the magic no.

If the value of N = (A-Z) is a magic number then those elements have large number of isotones. The maximum number of isotones occure in N=50 and 82 Krypton — 86 Uranium = 89 Radn - 88

ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51765

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 01
Roll No. : 8204
Class : BSc-II (TY)

Subject : Physics
Test / Tutorial No. : Internal Exam
Div. : A

Q.1
A] c) ~~Nucleons~~
1] c) Nucleons
2] a) Short ~~range~~ force
3] c) A=2

VIVEKANAND COLLEGE KOLHAPUR (AUTONOMOUS) ESTD JUNE 1964

Q.2

2)

liquid drop model for a nucleus:

1) The liquid drop model is proposed by Neils Bohr in 1937.
2) It makes the comparison between the drop of the liquid and nucleus of atom.
3) The nucleus is very small quantam particle.
4) The central core of atom is known as nucleus.
5) The drop of the liquid is macroscopic collection of particles.
6) When we compare drop of liquid and nucleus of atom, we can ~~observe~~ observe some accurate ~~pridictio~~ predictions about some properties of nucleus.
7) The similarities between nucleus of atom and drop of the liquid are as follows:-
   i) Both are containing large number of particles.
   ii) Both are homogenus and incompressible.
   iii) The density of drop of liquid is independent on its volume. Similarly, the nuclear mass density is independent on its volume.
   iv) Both shows surface tension. Because the nucleus just like drop of liquid tends to make spherical shape in the absence of external forces.
   v) In the nucleus, the nucleons are strongly interact with their neighbouring nucleons. It is similar to drop of the liquid where molecules only react with their neighbouring molecules.
   vi) The evaporation of molecules from the drop of liquid is similar to loss of nucleons from the nucleus when external energy provided.

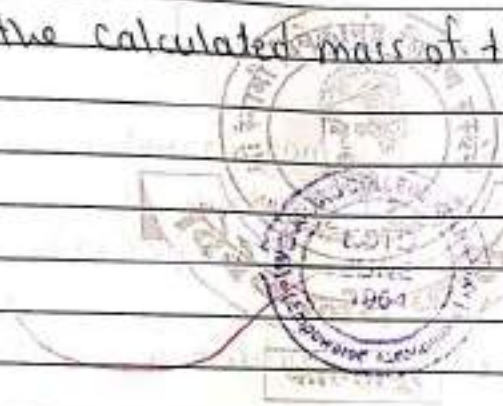
vii) When two small drops of liquid merge together to form a larger drop and when a larger drop is be breake into two small & indivial drops it is similar to fission and fusion of nuclei during nuclear reactions.

8) From the above point, we can compare a drop of liquid to nucleus of atom

9) When we compare them we can find some properties like nuclear fission.

10) It is helped to find the expression for nuclear mass. with the use of this expression we can find the mass of nuclei.

11) Hence, the calculated mass of the nucleus is fairly equal.



4) Magic Numbers :-

i) The observation of B.E curve shows some peaks over smooth curve.
ii) This indicates that some elements are more stable as compared to their neighbouring element.
iii) The calculation of B.E and the study of abundance of element in nature shows that some elements are more stable.
iv) When no. of protons or electrons of elements are equal to 2, 8, 20, 28, 50, 82, 126, then those elements are more stable.
v) This number of series is referred as magic numbers.

As number of evidences for magic number obtained by measuring the percentage of abundance.
For eg:- $^{16}_{8}O$ ($Z=8$, $N=8$), $^{120}_{50}Sn$ ($Z=50$), etc.

These elements are more abundant in nature, Hence they are more stable.

If the value of Z is a magic number then those elements have large number of isotopes.
For eg:- $^{16}_{8}O$ $^{17}_{8}O$ $^{18}_{8}O$, $Z=8$ and 8 is the magic no.

If the value of $N=(A-Z)$ is a magic number then those elements have large number of isotones.
The maximum number of isotones occurs in $N=50$ and 82
for eg:- '50' no. has 5 isotones.
Krypton - 86
Radon - 88
Yttrium - 89

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51781
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 02
Roll No. : 8204
Class : Bsc-III (TY)

Subject : Physics
Test / Tutorial No. : Internal exam
Div. : A

Q2
4) Zorinium - 90

Molybdanum - 92

If the value of Z and the value of N, both are magic numbers then those elements are most stable elements.
for eg:- $^{16}_{8}O$ $^{4}_{2}He$

3)

i) The central core of atom is known as nucleus. It contains proton and neutron and they both are called as nucleons.

ii) The number of protons is known as atomic number. It is denoted by Z.

iii) The ~~number~~ total number of protons and neutrons present in the nucleus is known as mass number and it is denoted by A.

iv) The number of neutrons is denoted by N. It can be ~~dene~~ found by $N = A - Z$.

v) By the number of protons we can put from one and from another.

vi) The intrinsic properties are as follows:-

1) Charge:-

Charge of the proton = 1.6×10^{-19} C

and neutron is electrically neutral.

2) Mass:-

Mass of proton and neutron are same as 1 amu.

$$1 \text{ amu} = \frac{1}{12} \times {}^{12}_{6}C \text{ isotope of carbon}$$

$M_p = 1.0073$ amu.

$M_n = 1.0087$ amu

$M_e = 0.00055$ amu

3) Magnetic moment:-

Magnetic moment is denoted by μ.

The spinnig charge is rise to magnetic moment

4) Spin angular moment :-
Nucleus are ferry angular moments of $\frac{h}{2}$.

5) ~~5)~~

5) Nuclear binding force :-
The nuclear held together by strong, short nuclear forces.
It is betn Proton - Proton
Neutron - Neutron
Proton - Neutron

"Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe
Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

B.Sc. Part-III SEM VI Examination (2023-24)

Quantum Mechanics

Date : Total Marks: 15

Day : Time :- 1 hour

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) Select correct alternative **(3)**

1) Quantum Numbers are solutions of _____

a) Heisenberg's Uncertainty Principle b) Einstein's mass energy relation

c) Schrodinger's Wave Equation d) Hamiltonian Operator

2) The Schrodinger time independent equation can be written as

a) $H\psi = E\psi$ b) $H\psi = (E\text{-}V)\,\psi$ c) $H\psi = (E+V)\,\psi$ d) $H\psi + E\psi = 0$

3)The quantum mechanical operator for the momentum of a particle in one dimension is given by

a) $i\hbar\frac{d}{dx}$ b) $-i\hbar\frac{d}{dx}$ c) $i\hbar\frac{\partial}{\partial t}$ d) $-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}$

Q.2 Attempt any Three **(12)**

1. Give requirements of wave function
2. Explain orthogonality and orthonormality of wave function.
3. Obtain Schrodinger s time dependent equation
4. Normalize the wave function $\psi = e^{\frac{-ax^2}{2}}$

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

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College (Autonomous), Kolhapur.

Department of Physics

B.Sc. III Internal Examination Oct-2023

Quantum Mechanics

Day and Date: Thursday, 26/10/2023 **Time:** 12-1pm

Roll No	Name of Students	Sign	Marks
8205	Sushant V Sutar	Sutar	
8203	Shrutika S Khot	Shrutika.	
8201	Shreyashree S Dorama	Dorama	
8202	Ruchi a Dongare		
8204	Misam Abhfak Pathan	Pathan	

VIVEKANAND COLLEGE KOLHAPUR
ESTD JUNE 1964
(Empowered Autonomous)

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
– शिवाजमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

51541

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. :

Roll No. : 82105

Class : B Sc III

Subject : Quantum Mechanics.

Test / Tutorial No. :

Div. :

M
15

Q 1)

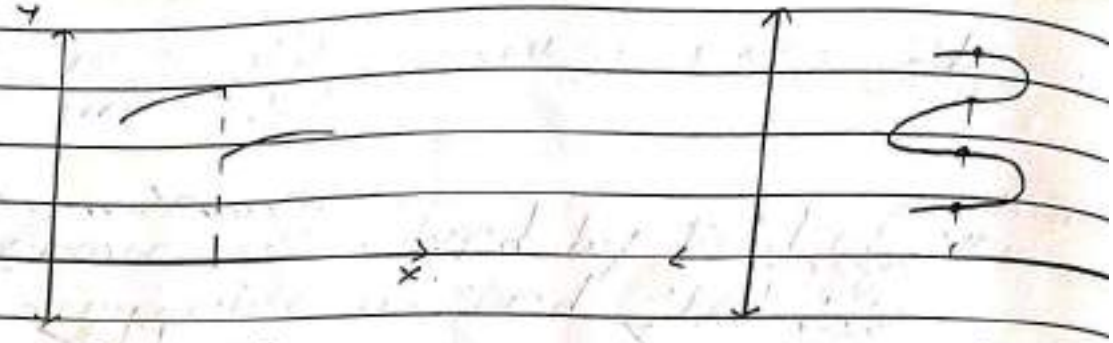
1) c) Schrodinger's wave equation

2) b) $H\psi = E\psi$

2

3) b) $-i\hbar \frac{d}{dH}$

Q 2)



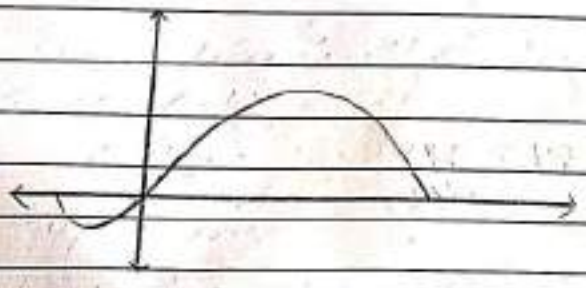
Discontinous

Not - single

infinite

Not well beha

y should be single value, finite and continous i/e. They are well behave



well behaviour.

The product of 1st wave function $\psi_1(x)$ and $\psi_2^*(x)$ vanishes when integrated with respect to x over the interval of $a \leq x \leq b$. The ψ_1 and ψ_2^* are said to be mutually orthogonals.

$$\int_a^b \psi_1(x)\, \psi_2^*(x)\, dx = 0$$

or

$$\int_a^b \psi_1^*(x)\, \psi_2(x)\, dx = 0$$

3)

consider Schrodinger's time dependent eqn

$$-\frac{\hbar^2}{2m}\frac{\partial^2\psi}{\partial x^2} + V\psi = E\psi = i\hbar\frac{\partial\psi}{\partial t} \quad \text{---(1)}$$

above eqn solved by help of variable and seperable method that is PS.

$$\psi = \psi(x)\,\phi(t)$$

put this value in eqn (1)

$$-\frac{\hbar^2}{2m}\frac{\partial^2\psi\phi}{\partial x^2} + V\psi\phi = i\hbar\frac{\partial\psi\phi}{\partial t}$$

$$-\frac{\hbar^2}{2m}\phi\frac{\partial^2\psi}{\partial x^2} + V\psi\phi = i\hbar\psi\frac{\partial\phi}{\partial t}$$

Divided by $\psi\phi$

$$-\frac{\hbar^2}{2m}\frac{\phi}{\psi\phi}\frac{\partial^2\psi}{\partial x^2} + \frac{V\psi\phi}{\psi\phi} = \frac{i\hbar\psi}{\psi\phi}\frac{\partial\phi}{\partial t}$$

$$-\frac{\hbar^2}{2m}\frac{1}{\psi}\frac{\partial^2\psi}{\partial x^2} + V = \frac{i\hbar}{\phi}\frac{\partial\phi}{\partial t}$$

To eliminate to 't'

Let us a L.H.S = E

$$L.H.S = E = R.H.S$$

$$-\frac{\hbar^2}{2m}\frac{1}{\psi}\frac{\partial^2\psi}{\partial x^2} + V = E$$

multiplying the $\frac{2m}{\hbar^2}\cdot\psi$

$$\frac{\partial^2\psi}{\partial x^2} - \frac{2m}{\hbar^2} + V\psi \cdot \frac{2m}{\hbar^2}\cdot E\psi$$

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 01

Roll No. :

Class :

Subject :

Test / Tutorial No. :

Div. :

$$\frac{d^2y}{dx^2} + \frac{2m}{x^2}(E - V)y = 0$$

This is a subsidiary of the Schrodinger equation.

4) The wave function which satisfied conditions.

$$\int_{-\infty}^{\infty} \psi \psi^* \, dx = \int_{-\infty}^{\infty} |\psi|^2 \, dx = \int_{-\infty}^{\infty} P \, dx = \int_{-\infty}^{\infty} \psi^* \psi \, dx$$

This is a normalize although the total probability of finding a particles at particular point in it's entire space is one when wave not normalize then can be made normalize to by multiplying particular constant A.

So, This result is wave function and also will be a solution of wave equation

$$\int_{-\infty}^{\infty} (A\psi)(A\psi) \, dx = 1$$

$$\int_{-\infty}^{\infty} A\psi^* \cdot A\psi \, dx = 1$$

$$A^2 \int_{-\infty}^{\infty} \psi^* \psi \, dx = 1$$

$$A^2 = \frac{1}{\int_{-\infty}^{\infty} \psi^* \psi \, dx}$$

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51533

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. :

Roll No. : 8202

Class : B.SC TY

Subject : Quantum Mechanics

Test / Tutorial No. : SEM V internal Examination

Div. :

08/15

1] Quantum Numbers are solution of

=> c] of Schrodinger's Wave Equation

2] The Schrodinger time independent equation can be written as b] $H\psi = (E-V)\psi$

2

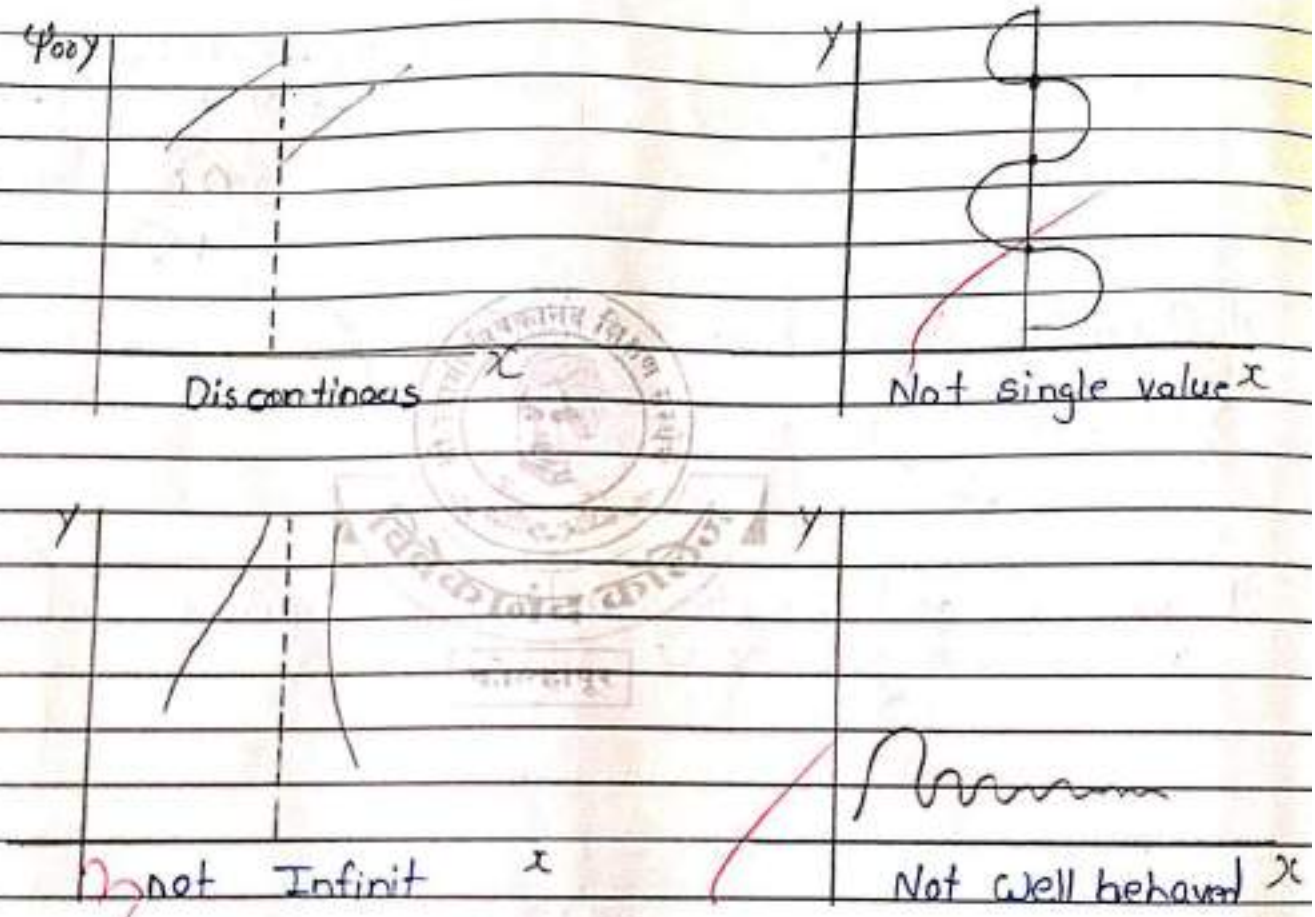
3] The quantum mechanical operator for the momentum of a particle in one dimension is given by

=> b] $-ih\frac{d}{dx}$

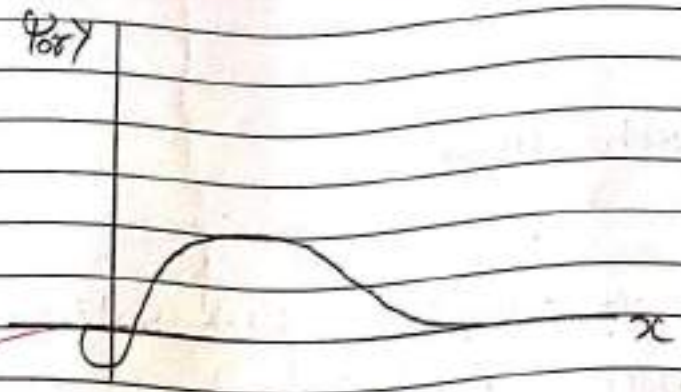
Q 2

ii

=> Requirements of wave function



~~Should be~~ Require: wave function should be continous
Infinit single value ~~or~~ ie well behaved.
wave function.



Well behaved

2]

⇒ The production of 1st wave function $\psi_1(x)$ and $\psi_2(x)$ vanishe when integrated with respected to x over the partical of area. The ψ_1 and ψ_2 are said to be mutally orthogonal.

$$\int_0^1 \psi_1(x)^2 \psi_2^2(x)\, dx = 0$$

$$\int_0^1 \psi_2^*(x)\, \psi_2(x)\, dx = 0$$

(a)

(b) Consider ~~schroedinger~~

(c)

⇒ Normalize wave function which satisfied conditions.

$$\int_{-\infty}^{\infty} \psi \psi^* \, d\tau = \int_{-\infty}^{\infty} |\psi|^2 \, d\tau = \int_{-\infty}^{\infty} \rho \, d\tau = \int_{-\infty}^{\infty} \psi^* \psi \, d\tau = 0$$

This is a normalized unite The total probability of ~~integration~~ condition finding a particle.

Name - Saad Sanjay Hasbe Date -

ज्ञान, विज्ञान आणि चुकांसंस्कार यांसाठी शिक्षण प्रसार

– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51534

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	

Suppliment No. : 1

Roll No. : 8430

Class : BSc-TY (Physics)

Subject : Quantum Mechanics

Test / Tutorial No. : Internal Exam

Div. : 1

13/15

Q1.

→1. c. Shrodinger's wave equation

Quantum Numbers are solutions of

→2. b. $H\psi = (E-V)\psi$

2

→3. b. $-i\hbar \frac{\partial}{\partial x}$

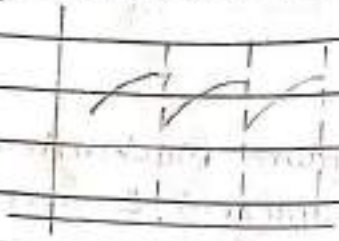
VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964

Q2.

1. Requirements of wave function

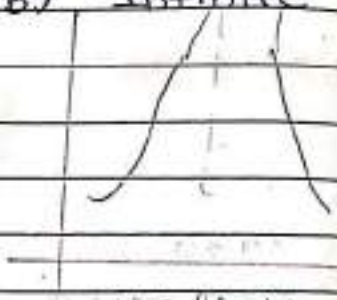
(1) The wave function should not be

A) Discontinuous



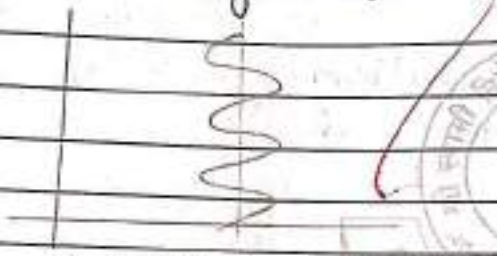
Discontinuous

B) Infinite



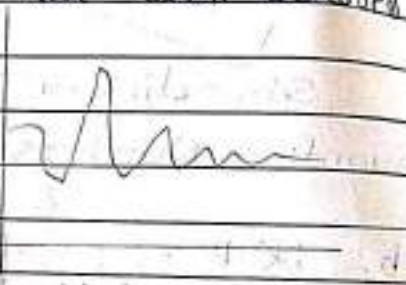
Infinite

E) Not single valued



Not single valued

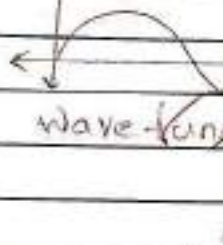
D) Not well behaved



Not well behaved

(2) The wave function should be continuous, finite, single valued and well behaved.

Eg:- Wave function graph



Wave function graph

2. (a) Orthoganality :-

i. When the product of two functions is integrated with respect to x, where $a \leq x \leq b$ in between interval a to b is equal to 0, then two functions are said to be orthogonal, (i.e. perpendicular)

(b) Orthogonormality :-

If wave function $\psi_1(x)$ & $\psi_2(x)$ products integration is zero between a to b where $a \leq x \leq b$ then wave function is orthogonal to other.

$$\int_a^b \psi_1(x) \cdot \psi_2(x) \, dx = 0$$

$$\int_a^b \psi_2(x) \cdot \psi_1(x) \, dx = 0$$

3. ~~Schrodinger's time dependent~~.

4. Normalize the wave function $\psi = e^{-ax^2/2}$

Given :- $\psi = e^{-ax^2/2}$

- To normalize wave function, we need multiply it by a constant A to both ψ & ψ^* (its complex conjugate.

$\therefore \psi = A \cdot e^{-ax^2/2}$ ① & $\psi^* = A^* \cdot e^{-ax^2/2}$ $(A^* = A)$

$$\therefore \int (A\psi)(A^*\psi^*) \cdot dx = 1$$

$$1 = \int_{-\infty}^{\infty} (A \cdot e^{-ax^2/2})(A \cdot e^{-ax^2/2}) \, dx$$

$$1 = \int_{-\infty}^{\infty} A^2 \cdot e^{-ax^2/2 + (-ax^2/2)} \, dx$$

$$1 = A^2 \int_{-\infty}^{\infty} e^{-ax^2} \cdot dx$$

Standard eq $\int_{-\infty}^{\infty} e^{-\alpha x^2} = \sqrt{\frac{\pi}{\alpha}}$

$\therefore 1 = A^2 \sqrt{\frac{\pi}{a}}$

$A^2 = \sqrt{\frac{a}{\pi}}$

$A = \frac{a^{1/4}}{\pi^{1/4}}$

$\therefore$ Eq^n (1) becomes $\psi = \frac{a^{1/4}}{\pi^{1/4}} \times e^{-ax^2/2}$

→3. Schrodinger's time dependent equation

We have, wave function,

$\psi = A \cdot e^{i(kx - \omega t)}$ ——— (1)

ψ = (psi) wave function, k = constant

x = displacement, $(kx - \omega t)$ = phase = θ

ω = angular moment, A = Amplitude

t = time.

By De-broglie & planck formula

$p = \frac{h}{\lambda}$ $\quad \varepsilon = h\nu$

$p = \frac{h}{2\pi} \times \frac{2\pi}{\lambda}$ $\quad \varepsilon = \frac{h}{2\pi} \times \frac{2\pi}{\nu}$

$\therefore p = \hbar \times k$ $\quad \therefore \varepsilon = \hbar \times \omega$ $\quad \left(\hbar = \frac{h}{2\pi}\right)$

$\therefore k = \frac{p}{\hbar}$ ——— (1) & $\therefore \omega = \frac{\varepsilon}{\hbar}$ ——— (2)

Diff eq^n (1) w.r.t x & t

$\frac{\partial \psi}{\partial x} = A \cdot e^{i(kx - \omega t)} (ik)$ $\quad \frac{\partial \psi}{\partial t} = A \cdot e^{i(kx - \omega t)} (-i\omega)$

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे
51544
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)
SUPPLIMENT
Signature of Supervisor
Suppliment No. :
Roll No. : 8430
Class : BSc-TY (Phy)
Subject :
Test / Tutorial No. : Internal Exam.
Div. :

As, $\psi = A \cdot e^{i(kx-\omega t)}$

$\therefore \frac{\partial \psi}{\partial x} = \psi \cdot (ik)$ | $\frac{\partial \psi}{\partial t} = -\psi \cdot (i\omega)$

$\frac{\partial \psi}{\partial x} = i\psi \cdot \frac{p}{\hbar}$ | $\frac{\partial \psi}{\partial t} = -i\psi \frac{E}{\hbar}$

$p\psi = \frac{\partial \psi}{i \partial x} \times \hbar$ | $E\psi = -\frac{\partial \psi}{i \partial t} \hbar$

$p\psi = -i\frac{\partial \psi}{\partial x}\hbar$ | $E\psi = i\frac{\partial \psi}{\partial t}\hbar$

$\therefore \hat{p} = -\hbar i \frac{\partial}{\partial x}$ | $\therefore \hat{E} = \hbar i \frac{\partial}{\partial t}$

$\hat{p}$ = momentum operator; $\hat{E}$ = Energy operator.

As we now,

$$T.E = K.E + P.E$$

$$K.E = \frac{1}{2}mv^2 \times \frac{m}{m} = \frac{1}{2}\frac{m^2v^2}{m} = \frac{1}{2}\frac{p^2}{m} \quad (p = mv)$$

$P.E = V$ & $T.E = E$

$\therefore E = \frac{p^2}{2m} + V$

$\therefore$ In quantum mechanics apply operator to derive.

$$i\hbar\frac{\partial \psi}{\partial t} = \frac{\left(-i\hbar\frac{\partial \psi}{\partial x}\right)^2}{2m} + V\psi$$

$$i\hbar \frac{\partial \psi}{\partial t} = \frac{\hbar^2}{2m} \frac{\partial^2 \psi}{\partial x^2} + V\psi$$

This is Schrodinger wave Equation for time dependent in one direction,

∴ for 3-D, $\therefore i\hbar\nabla = \frac{\hbar^2}{2m} \nabla^2 + V\psi$

"Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe
Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

B.Sc. Part-III SEM V Examination (2023-24)
Solid state physics

Date: Total Marks: 15
Day: 12.00 to 1.00 pm Time: -

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) Select correct alternative **(3)**

1. The primitive cell of the crystal contains ----------atoms per unit cell.
   (a) one (b) two
   (c) more than two (d) two or more than two

2. The full crystallographic symmetry of a cube is --------.
   (a) 13 (b) 9
   (c) 23 (d) 20

3. The Miller indices of a plane which cut the x-axis at half way of the unit cube are given by ----
   (a) (2 0 0) (b) $(\frac{1}{2}\ 0\ 0)$
   (c) $(0\ \frac{1}{2}\ 0)$ (d) $(0\ 0\ \frac{1}{2})$

Q.2 Attempt any THREE **(12)**

1. Discuss plane of symmetry of cubic crystal.
2. Calculate the packing fraction of Hexagonal closely packed structure.
3. Write a note on NaCl crystal structure.
4. Write a note two dimensional Bravise lattices.

Vivekanand College, Kolhapur (Empowered Autonomous)
Department of Physics
Internal Examination 2023-24
B.Sc. III Physics (SEM V)
Date :- 26/10/2023

Sr. No.	Roll No.	Student Name	Sign	Marks
1	8201	DEMANNA SHREYASHREE SHANTINATH		
2	8202	DONGARE RUSHI CHANDRAKANT		
3	8203	KHOT SHRUTIKA SAMBHAJI		
4	8204	PATHAN MISAM ASHFAK		
5	8205	SUTAR SUSHANT VILAS		

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

।। ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।।

– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51946

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	9/15

Suppliment No. : 01

Roll No. : 8204

Class : BSc-III (TY)

Subject : Solid states physics

Test / Tutorial No. : Internal Exam

Div. : A

Q.1

1) a) One

2) c) 23

3) b) $(\frac{1}{2}\,0\,0)$

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Q.2

2)

Packing fraction of hexagonal closely packed structure :-

The packing fraction = $\frac{\text{Volume of atom}}{\text{Volume of unit cell}}$ — (I)

i) Determination of volume of atom :-

The lower layer of HCP ~~contains~~ structure contains 6 atoms,

∴ So its share to unit cell is $\frac{1}{6}$

The middle layer of HCP structure contains 3 atoms,

∴ So its share to unit cell is 3.

The centre of HCP structure contain 1 atom

∴ So its share to unit cell is $1/2$

The number of atom per unit cell = $\left[\frac{1}{6} \times 12 + 3 + \frac{1}{2} \times 2\right]$

∴ Number of atom per unit cell = 6

The atom is spherical in nature

Volume of atom = Volume of sphere

∴ Volume of atom = $\frac{4}{3}\pi r^3$

But in HCP structure unit cell contain 6 atoms.

Then above eqⁿ becomes,

Volume of atom = $\frac{4}{3}\pi r^3 \times 6$ 2

∴ Volume of atom = $8\pi r^3$ — (II)

ii) Determination of volume of unit cell:-

If we joint the centre atom of bottom layer with their adjcent atoms it makes 6 equilateral triangle.

∴ So, Volume of unit cell = Area of triangle × c × 6

$$= \frac{\sqrt{3}}{4} a^2 \times c \times 6$$

Where $\frac{\sqrt{3}}{4} a^2$ = area of triangle

c = height of unit cell

a = Interatomic distance

$$\therefore \text{Volume of unit cell} = \frac{3\sqrt{3}\, a^2 \times c}{2} \quad \text{— (III)}$$

Substituting eqn (II) and eqn (III) in eqn (I),

$$\text{Packing fraction} = \frac{8\pi r^3}{\frac{3\sqrt{3}\, a^2 \times c}{2}}$$

$$\text{Packing fraction} = \frac{16\pi r^3}{3\sqrt{3}\, a^2 \times c}$$

Put $r = \frac{a}{2}$

$$\text{Packing fraction} = \frac{16\pi \left(\frac{a}{2}\right)^3}{3\sqrt{3}\, a^2 \times c}$$

$$= \frac{16\pi \frac{a^3}{8}}{3\sqrt{3}\, a^2 \times c}$$

Packing fraction = $\frac{2\pi}{3\sqrt{3}} \times \frac{a}{c}$

from the geomatry of the figure,

$\frac{c}{a} = 1.64$

Put this value in above eqn,

Packing fraction = $\frac{2\pi}{3\sqrt{3} \times 1.64}$

$\therefore$ Packing fraction = 0.74

$\therefore$ The packing fraction of Hexagonal closely packed structure is 0.74.

।। ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।।
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51991
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

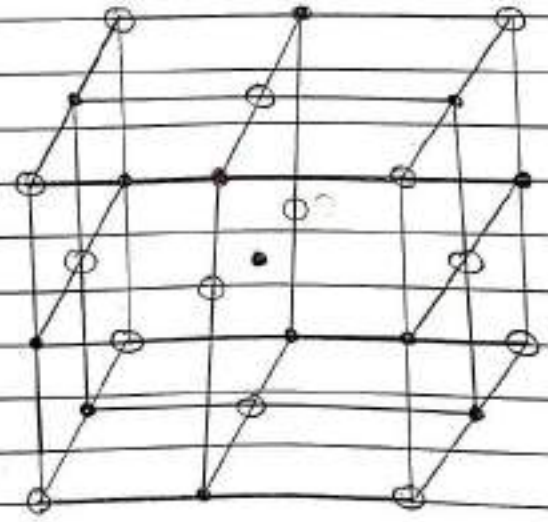
Signature of Supervisor

Suppliment No. : 02
Roll No. : 8204
Class : BSc-III

Subject : Physics.
Test / Tutorial No. : Internal exam
Div. : A

3) NaCl crystal structure :-

i) NaCl Crystal Structure is known as rock salt.
ii) Na particle losses the outermost electron and become the positively charged particle.
iii) Cl particle gain 1 electron that losses from Na particle and become the negatively charged particle.
iv) Na becomes Na^+ and Cl becomes Cl^-.
v) In unit cell Na^+ have 13 ~~atoms and~~ ions and Cl^- have 14 ions. That is shown in below,



~~vi) In the unit cell, the Na^+ ions are 12 atoms~~

vi) In this unit cell, Na^+ ions are 13. ~~Which are~~
The 12 atoms of Na^+ is on centre of the edge of unit cell and 1 atom is at centre.

vii) In this unit cell, Cl^- ions are 14.
The 8 atoms are located on ~~the~~ corners of unit cell and 6 atoms are face centered.

42 i) If in space lattice all atoms are indivial and identical then it is called as Bravis lattice.

ii)
There are three type :-

1) Oblique lattice :-

2) Squar lattice :-

3) Hexagonal Cattice :-

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51944
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor: 04/15

Suppliment No. :
Roll No. : 8202
Class : B.SC TY

Subject : Solid state Physics
Test / Tutorial No. : SEM V Integral Exam
Div. :

Q 1

1] The primitive cell of the crystal contains a] one atoms per unit cell.

2] The full crystallographic symmetry of a cube is ~~a] 13~~ ~~b] 20~~ c] 23

3] The miller indices of a plane which cut the x-axis at half way of the unit cube are given by b] $(\frac{1}{2}\,00)$

Q2

=> Packing fraction :- It is the ratio of the volume of atoms per unit cell to volume of unit cell.

∴ PF = $\frac{\text{Volume of atoms unit cell}}{\text{Volume of unit cell}}$

PF do HCP Hexagonal closely packed structure.

।। ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ।।

– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

51947

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Supplment No. :

Roll No. : 3210

Class : BSc III

Subject : SOIPd state phy

Test / Tutorial No. :

Div. :

12/15

Q.1

1) a) one

2) c) 23

3) b) $(\frac{1}{2}00)$

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964

Q 2)

2)

packing fraction = volume of atom / unit
volume of unit cell

i) Determination of volume of atom / unit

lower layer contain 6 atom
so, it's share to unit cell = $\frac{1}{6}$

middle layer contain 3 atom
so, it's share to unit cell = 3

centre layer contain 1
so, it's share to unit cell = $\frac{1}{2}$

Now,
no. of atom per unit cell

$$\left[\frac{1}{6} \times 12 + 3 + \frac{1}{2} \times 2\right] = 6$$

atom is of spherical volume
∴ volume of atom = volume of spherical
$= \frac{4}{3} \pi r^3$ —

∵ HCP contain 6 face centred.

$= \frac{4}{3} \pi r^3 \times 6 = 8 \pi r^3$ —

(ii) Determination of volume of unit cell.

If we join the central no. with the all adjecunt no. of bottom layer That 6 equilateral triangles.

vol^m of unit cell = Area of triangle x height of unit x 6

$= \frac{\sqrt{3}}{4} a^2 \times c \times 6$

so, Area of triangle is $\frac{\sqrt{3}}{4} a^2$

c. is height of unit cell.

$\frac{\sqrt{3}}{4} a^2 \times c \times 6$ ——— III

Substituting of II and III in eq^n (I)

$= \frac{8\pi r^3}{\frac{\sqrt{3}}{4} a^2 \times c \times 6}$

Packing fraction: $\frac{16\pi r^3}{3\sqrt{3} a^2 c}$

$r = \frac{a}{2}$

so, packing fraction: $\frac{16\pi \frac{a^3}{8}}{3\sqrt{3} a^2 c}$

$= \frac{2\pi}{3\sqrt{3}} \times \frac{a}{c}$

The format geometry for

$\frac{c}{a} = 1.64$

So Packing fraction: $\frac{2\pi}{3 \times 1.64 \times \sqrt{3}}$

$PF = 0.74$

04

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's 51988

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor :

Suppliment No. : 01.

Roll No. :

Class :

Subject :

Test / Tutorial No. :

Div. :

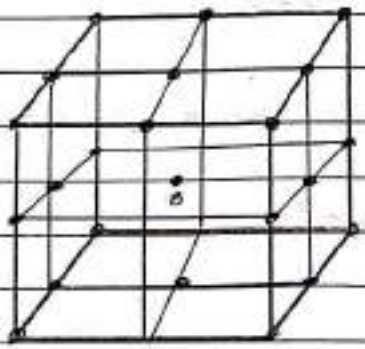
3)

→ 1) It is also called as rock salt

2) In a sodium chloride the sodium atom losses their outermost electrons and aquired positive charge

3) while the chlorine ions gain one electron and by losses the sodium atom. and aquired negative charge. (Cl^-)

4) The Cl^- ions contains 14 atoms & Na^+ ions contains 13 atoms.



= 14 Cl^-

= 13 Na^-

5) chloride ions consist 8 corner atoms & centre of 6 FCC. Thus they have 14 ions.

6) sodium ions consist 12 face centred at edges and remaining 1 is Body centre unit. Thus they have 13 ions.

7) The NaCl can be a FCC unit cell & 1 Cl^- and 1 Na^+.

8)

9) It no. of atoms in lattice point is one identical as the lattice is called a Bravise lattices.

They have 3 types

1) oblique lattices

this is does not equal to a ≠ b and $\beta = 90°$.

2) square lattice

The square lattice is $a = b$.

and $\theta = 120^\circ$

3) Hexagonal lattice.