Vivekanand College, Kolhapur. (Autonomous)
Department of Physics
Internal Examination Notice
2018-19

Date: 21/01/2019

All students of class B.Sc. I, B.Sc. II and B.Sc. III are hereby noticed that the second 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 three 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 three 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 three 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 three questions) for 10 marks

Internal Evaluation Examination 2018-19.
SEM II, SEM IV and SEM VI
Time Table

Sr. No.	Class	Paper	Date	Time
1.	B.Sc. I	Paper II	28/01/2019	11:00 am to 12:00 pm
2.	B.Sc. II	Paper IV	28/01/2019	11:00 am to 12:00 pm
3.	B.Sc. II (Astrophysics)	Paper II	29/01/2019	11:00 am to 12:00 pm
4.	B.Sc. III	Paper VII (section I)	30/01/2019	11:00 am to 12:00 pm
		Paper VII (section II)		01:00 am to 02:00 pm
		Paper VIII (section I)	31/01/2019	11:00 am to 12:00 pm
		Paper VIII (section II)		01:00 am to 02:00 pm

HOD

Head of the
Department of Physics
Vivekanand College, Kolhapur

VIVEKANAND COLLEGE ESTD JUNE 1964 KOLHAPUR - 416003

Vivekananda College Kolhapur (Autonomous).

Department of Physics: Internal examination 2018-19

B.Sc. III Semester V

Subject: Electrodynamics and Electromagnetic Waves

Marks: 20 (Each question carry one mark) **Time : 20 min**

Q.1 Attempt any ONE **(10)**

1. Derive Poisson's equations and their physical significance
2. Derive Laplace's equations and their physical significance

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

1. Discuss Laplace's equation in one dimension and its solution(Cartesian co-ordinate).
2. Derive an expression for motion of charged particle in uniform electric field.
3. Derive an expression for uniform magnetic field.

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(Autonomous)

Department of Physics

Internal exam

B.Sc. III Sem VI

Attendance Sheet

Roll No.	Name Of The Student	Signature			
		30-01-19	30-01-19	31-01-19	31-01-19
8501	Aniket Nandkumar Chile	Achile	Achile	Achile	Achile
8502	Shubham Nandkumar Chodankar	SNC	SNC	SNC	SNC
8503	Ankita Jayawant Chougule	AC	AC	AC	AC
8504	Patil Pramod Dashrath	Patil	Patil	Patil	Patil
8505	Ankita Ravindra Digraje	AR	AR	AR	AR
8506	Pooja Lagamana Ghulanawar	Pooja	Pooja	Pooja	Pooja
8507	Prasad Rajaram Gulavani				
8508	Vinayak Baburao Kesarkar	VK	VK	VK	VK
8509	Aishwarya Sanjay Kumbhar	Akumbhar	Akumbhar	Akumbhar	Akumbhar
8510	Karale Prajakta Mansing				
8511	Shamal Vijay Mohite	SMohite	SMohite	SMohite	SMohite
8512	Tejaswini Tanaji Musale	TMusale	TMusale	TMusale	TMusale
8513	Anisa Ajij Nadaf	Anisa	Anisa	Anisa	
8514	Somesh Krishnat Nerlekar				
8515	Sourabh Sanjay Patil				
8516	Anuja Uday Patil	APatil	APatil	APatil	APatil
8517	Pranil Yuvraj Patil				
8518	Pratiraj Sampat Patil				
8519	Satish Shivaji Patil				
8520	Sheral Shivaji Patil				
8521	Shrinath Dhondiram Shinde				
8522	Kumbhar Swaroop Sunil				
8523	Ajit Sadashiv Thorat				
8524	Ruhan Eliyas Ustad				
8525	Vaibhav Vasant Yadav	Vyadav	Vyadav	Vyadav	Vyadav

Internal Examinar.....

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

Name : Jeevan Maruti Yatil

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- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Signature of Supervisor

Shri Swami Vivekanand Shikshan Sanstha's

VIVEKANAND COLLEGE (Autonomous), KOLHAPUR

18/20

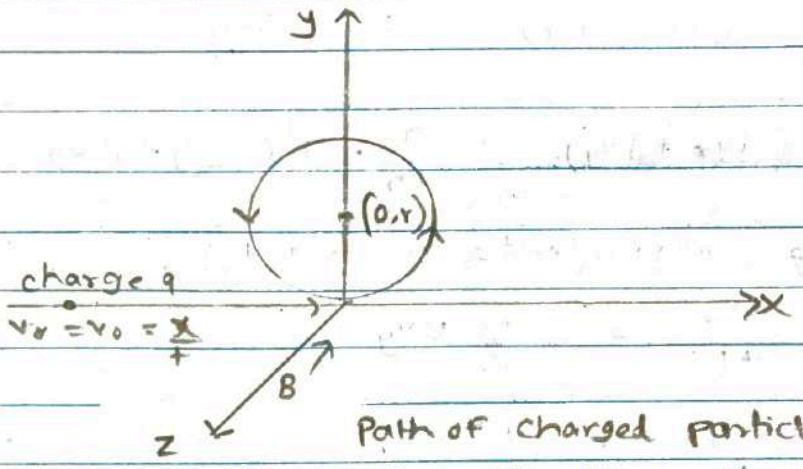
Class B.Sc. III Div. Roll No. 5018

Suppliment No. Subject Physics XX

Test / Tutorial No. Internal Exam

Q. Derive an expression for motion of charge particle in constant uniform magnetic field.

Let us consider a charge particle of charge q and mass m moving in constant magnetic field B.



Path of charged particle in uniform B field

Under the action of these magnetic field, the charge particle moves in a plane perpendicular to B i.e. in x-Y plane. The force acting on a charged particle because of magnetic field B is.

$$F = q(V \times B) \quad \text{— (1)}$$

Let, i,j,k be the unit vectors along x, y, z axes respectively. ∴ if v_x and v_y are component of velocities of the charged particle along x and y directions respectively.

$$v = iv_x + jv_y \quad \text{— (2)}$$

According to Newton's second law of motion, force acting on the charged particle is

$$F = m \cdot \frac{dv}{dt} \quad \text{—}$$

10

ESTD (3) (Autonomous)

$$\therefore \quad \frac{dv}{dt} = i\omega\, dt \qquad \text{— (9)}$$

Intergrating above eqn for velocity & time

$$\int_{v_0}^{v} \frac{dv}{v} = \int_{0}^{t} i\omega\, dt$$

$$\therefore \quad [\log v]_{v_0}^{v} = i\omega [t]_0^t$$

$$\therefore \quad \log v - \log v_0 = i\omega t \qquad \text{— (10)}$$

$$\log\left(\frac{v}{v_0}\right) = i\omega t$$

$$\therefore \quad \frac{v}{v_0} = e^{i\omega t}$$

$$\therefore \quad v = v_0 e^{i\omega t}$$

But $v = v_x + i v_y$

and $e^{i\omega t} = \cos\omega t + i\sin\omega t$

equation becomes

$$(v_x + i v_y) = v_0 (\cos\omega t + i\sin\omega t) \qquad \text{— (11)}$$

comparing real & imaginary parts on both sides

$$v_x = v_0 \cos\omega t \qquad \text{— (12)}$$

$$v_y = v_0 \sin\omega t \qquad \text{— (13)}$$

squaring & adding equation

$$v_x^2 + v_y^2 = v_0^2 \cos^2\omega t + v_0^2 \sin^2\omega t$$

$$v_x^2 + v_y^2 = v_0^2$$

$$\sqrt{v_x^2 + v_y^2} = v_0$$

$$\therefore \quad v = v_0$$

Further,

$$v_x = dx/dt$$

$$\therefore \quad \frac{dx}{dt} = v_0 \cos\omega t$$

$$dx = v_0 \cos\omega t \cdot dt$$

Integrate above equations

$$\int_0^x dx = \int_0^t v_0 \cos\omega t \cdot dt$$

$$\therefore \quad x = \frac{v_0}{\omega} \sin\omega t + k \qquad \text{— (14)}$$

k is constant of intergration, At $t=0$, $x=0$ and $k=0$

$$v_y = dy/dt$$

$$\therefore \quad dy/dt = v_0 \sin\omega t$$

$$\therefore \quad dy = v_0 \sin\omega t \cdot dt$$

Integrate above eqn

$$\int_0 dy = \int_0^t v_0 \sin\omega t$$

$$\therefore \quad y = \frac{-v_0}{\omega} \cos\omega t + k \qquad \text{— (15)}$$

At $t=0$, $y=0$ then

$$0 = -v_0/\omega + k$$

$$\therefore \quad k = v_0/\omega$$

Hence equation (15) changes to

$$y = -\frac{v_0}{\omega} \cos\omega t + v_0$$

$$\therefore \quad y = \frac{v_0}{\omega} - \frac{v_0}{\omega} \cos\omega t \qquad \text{— (16)}$$

But $\frac{v_0}{\omega} = r$ = radius of path taken by charged particle

$$\therefore \quad x = r\sin\omega t \qquad \text{— (17)}$$

$$y = r - r\cos\omega t \qquad \text{— (18)}$$

$$y - r = -r\cos\omega t \qquad \text{— (19)}$$

Squaring and adding eq (18) and (19)

$$x^2 = (y-r)^2 = r^2\sin^2\omega t + r^2\cos^2\omega t$$

$$x^2 + (y-r)^2 = r^2 \qquad \text{— (20)}$$

this eqn is equation of circle with centre (0, radius r.

∴ Thus motion of charged particle in B field is circular

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Signature of Supervisor

Shri Swami Vivekanand Shikshan Sanstha's

VIVEKANAND COLLEGE (Autonomous), KOLHAPUR

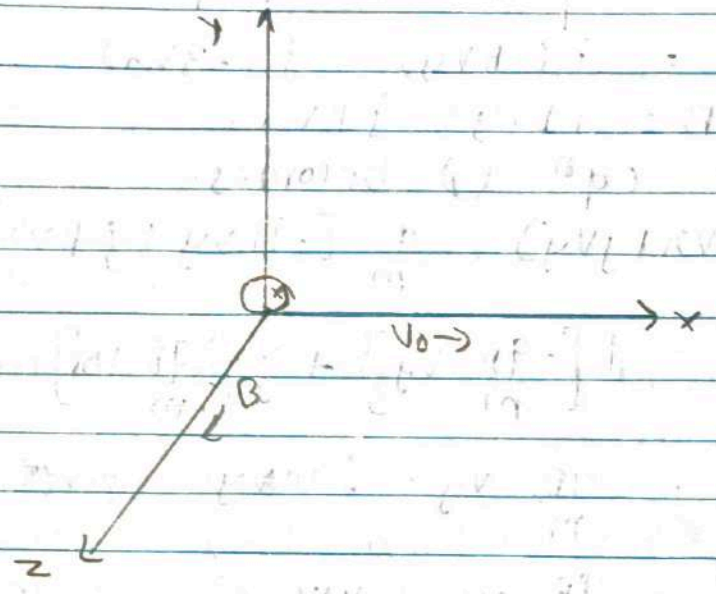
15/20

Class B.Sc - III Div Roll No. 8019

Suppliment No. Subject physics

Test / Tutorial No. ~~Internal~~ Exam - 1, ~~Surprise~~

Ans - 1 The motion of P charged particle in a constant uniform magnetic field.



Consider charge particle q of mass a moving with velocity v_0 along the x axis Let it enters in a constant uniform magnetic field B directed along -ve 'z' direction. Due to magnetic field particle experience magnetic force fm & it is given by.

$$fm = q(v \times B) \quad \text{— (1)}$$

Where v = velocity of particle in M.F.
Under the act° of magnetic force fm the particle moves in a direction ⊥st to B & v. i.e the particle moves in x, y plane with velocity 'v' & it is given by

10

$v = iV_x + jV_y$ — (2)

Acc to Newton's 2nd law we have,

$$Fm = ma = \frac{m\,dv}{dt} \quad — (3)$$

We have $v = iV_x + jV_y$

$B = -kB$

$$\therefore V \times B = \begin{vmatrix} i & j & k \\ V_x & V_y & 0 \\ 0 & 0 & B \end{vmatrix}$$

$$= i(-BV_y) - j(-BV_x)$$

$$V \times B = iBV_y + jBV_x$$

Hence eqn (2) becomes.

$$\frac{d}{dt}[iV_x + jV_y] = \frac{q}{m}[-iBV_y + jBV_x]$$

$$= i\left[\frac{-qB}{m} V_y\right] + j\left[\frac{qB}{m} V_x\right]$$

$$\frac{dV_x}{dt} = \frac{-qB}{m} V_y = -\omega V_y \quad — (5)$$

$$\frac{dV_y}{dt} = \frac{qB}{m} V_x = \omega V_x \quad — (6)$$

where $\omega = \frac{qB}{m}$

multiplying eqn (6) by imaginary no i & adding in eqn (5)

$$\frac{dv_x}{dt} + i\frac{dv_y}{dt} = -\omega v_y + i\omega v_x$$

$$\frac{d}{dt}[V_x + iv_y] = i\omega[V_x + iv_y]$$

put $V_x + iV_y = V$ — (7)

we get.

eqn ① is a diffn eqn of the Ist order.

$$\frac{dv}{v} = i\omega dt.$$

Integrating at both side.

$$\int_{v_0}^{v} \frac{dv}{v} = \int i\omega \, dt$$

$$[\log v]_{v_0}^{v} = i\omega t.$$

$$\log \frac{v}{v_0} = i\omega t$$

$$\frac{v}{v_0} = e^{i\omega t}.$$

$$v = v_0 e^{i\omega t}.$$

Substituting value of v, we get,

$$v_x + iv_y = v_0 e^{i\omega t}.$$

$$v_x + iv_y = v_0 [\cos \omega t + i \sin \omega t]$$

$$v_x + iv_y = v_0 \cos \omega t + iv_0 \sin \omega t.$$

Equating real terms & imaginary terms.

$$v_x = v_0 \cos \omega t.$$

$$v_y = v_0 \sin \omega t.$$

Consider

$$v_x = v_0 \cos \omega t.$$

$$\frac{dx}{dt} = v_0 \cos \omega t$$

$$dx = v_0 \cos \omega t \, dt$$

Integrating at both sides.

$$\int dx = v_0 \int \cos \omega t \, dt.$$

$$x = v_0 \frac{\sin \omega t}{\omega t}.$$

Now consider

$V_y = V_0 \sin \omega t$

$\frac{dy}{dt} = v_0 \sin \omega t.$

$dy = V_0 \sin \omega t \, dt.$

on integrating

$\int dy = v_0 \int \sin \omega t \, dt.$

$y = \frac{v_0}{\omega} [\cos \omega t]_0^t = \frac{v_0}{\omega} [\cos \omega t - 1]$

$y = -r (\cos \omega t - r)$

$y = -r - r \cos \omega t \quad -(8)$

$y - r = -r \cos \omega t \quad -(9)$

squaring & adding eqn (8) & (9) we get.

$x^2 + (y-r)^2 = r^2$

Above eqn is eqn of circle which given trajectory of particle is circular.

Vivekananda College Kolhapur (Autonomous).

Department of Physics: Internal examination 2018-19

B.Sc. III Semester V

Subject: Energy Studies and Materials Science

Marks: 20 (Each question carry one mark) Time : 20 min

Q.1 Attempt any ONE **(10)**

1. Discuss briefly wind energy, wind energy chains, wind energy quantum
2. Write a note on Efficiency factor of wind turbine(P-H graph).

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

3. Write a note on Classification of energy resources.
4. What are the types of types of a wind turbine generator unit.
5. Define the factors : a) wind energy chains, b) wind energy quantum, c) wind power density, d) power of wind turbine for a given incoming wind velocity

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

15/2

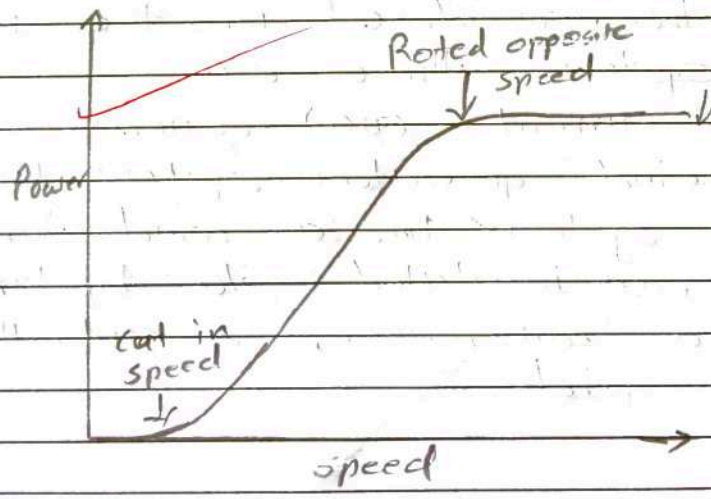
Suppliment No. :
Roll No. : 8525
Class : B.Sc. III, sem-V

Signature of Supervisor

Subject : Energy studies and material science
Test / Tutorial No. : Internal exam
Div. :

Q.1

27 The power output of wind turbine depends on where it is located, as well as the physical characteristics of the turbine itself. It is highly unlikely that the wind speed will be steady in any location, and ∴ the output will vary in line with the speed at any one time. This is where a wind turbine power curve can help to estimate current and near future output.



At very low wind speeds, there is insufficient torque exerted by the wind on the turbine blades to make them rotate. However, as the speed increases, the wind turbine will region to rotate and generates electrical power.

The speed at which the turbine first start to rotate and generate power is called the cut-in-speed, and is typically bet^n 3 and 4 meteres per second.

The available power in a stream of wind of the same cross sectional area as the wind turbine can easily be shown to be

$$\frac{1}{2} \rho v^3 \frac{\pi d^2}{4}$$

If the wind speed v is in meter per second, the density ρ is in kilograms per cubic meter and the rotor diameter d is in meters then the available power in watts.

Q-2

2) There are four types of wind turbines generator which can be considered for the various wind turbine systems those are

1. Direct current (DC) generators

A wind generator system has a wind generator system has a wind turbine, a DC generator, an insulated gate bipolar transistor inverter, a transformer, a controller, and a power grid

2. Ac synchronous Generator :-

Ac synchronous wind turbine generators can take constant or DC excitation from either permanent magnets of electromagnets.

03 3. Switched Reluctance wind Turbine Generator

switched relutance wind turbine generators have features such as strong rotar and stator.

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SUPPLIMENT

Signature of Supervisor

Suppliment No. : 19/20

Roll No. : 8513

Class : B.Sc III, Sem-V

Subject : Energy Studies and Material Science

Test / Tutorial No. : Internal Exam

Div. :

Q. 2)

3) (a) Wind energy chains - The wind power value chain incorporates five main stages : materials, components, manufacture, logistics, development and operations.

(b) Wind energy Quantum - Wind energy is a form of Solar energy, meaning that it originates from the sun. The Sun heats the atmosphere unevenly so that the temperature varies at different places.

(c) Wind Power Density - Wind power density is a quantitive measure of wind energy available at any location. It is the mean annual power available per square meter of swept area of a turbine. 05

(d) Power of wind turbine - Wind turbines convert the kinetic energy in the wind into mechanical power. The mechanical power can be used for specific tasks.

Q 2)

2) There are four types of wind turbines generator which can be considered for the various wind turbine systems those are:

1. Direct Current (DC) generators-

A wind generator system has a wind turbine, a DC generator, an insulated gate bipolar transistor inverter, a transformer, a controller, and a power grid

2. AC Synchronous Generator -

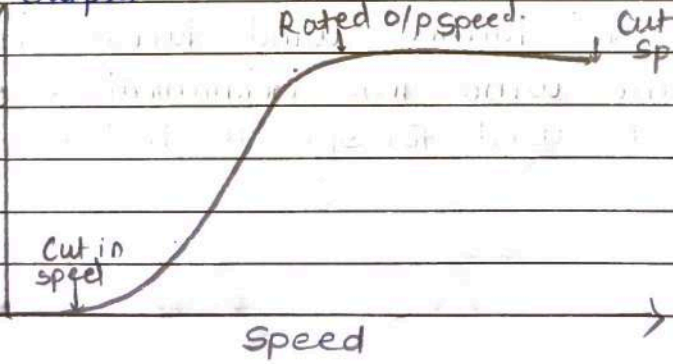
AC synchronous wind turbine generators can take constant or DC excitations from either permanent magnets or electromagnets.

3. Switched Reluctance Wind Turbine Generator -

Switched reluctance wind turbine generators have feature such as strong rotor and stator.

Q.1)

2) The power output of a wind turbine depends on where it is located, as well as the physical characteristics of the turbine itself. It is highly unlikely that the wind speed will be steady in any location, and therefore the output will vary in line with the speed at any one time. This is where a wind turbine power curve can help to estimate current and near future output.



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The available power in a stream of wind of the same cross sectional area as the wind turbine can easily be shown to be : $\frac{1}{2} \rho U^3 \frac{\pi d^2}{4}$

If the wind speed U is in meters per second, the density ρ is in kilograms per cubic meter and the rotor diameter d is in meters then the available power in watts.

Vivekananda College Kolhapur (Autonomous).

Department of Physics: Internal examination2018-19

B.Sc. III Semester VI

Subject: Nuclear and Particle Physics

Marks: 20 (Each question carry one mark) **Time : 20 min**

Q.1 Attempt any ONE **(10)**

1. Explain the Cyclotron- construction, working, theory- expression for energy of cyclotron and its limitations
2. Explain the Synchro-cyclotron construction, working and its advantages, disadvantages.

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

1. Discuss the principle of Principle of phase stable orbits
2. Derive the expression for Betatron expression of energy gain.
3. Write a note on Need of accelerators.

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 15/20

Roll No. : 8509

Class : BSc III sem V

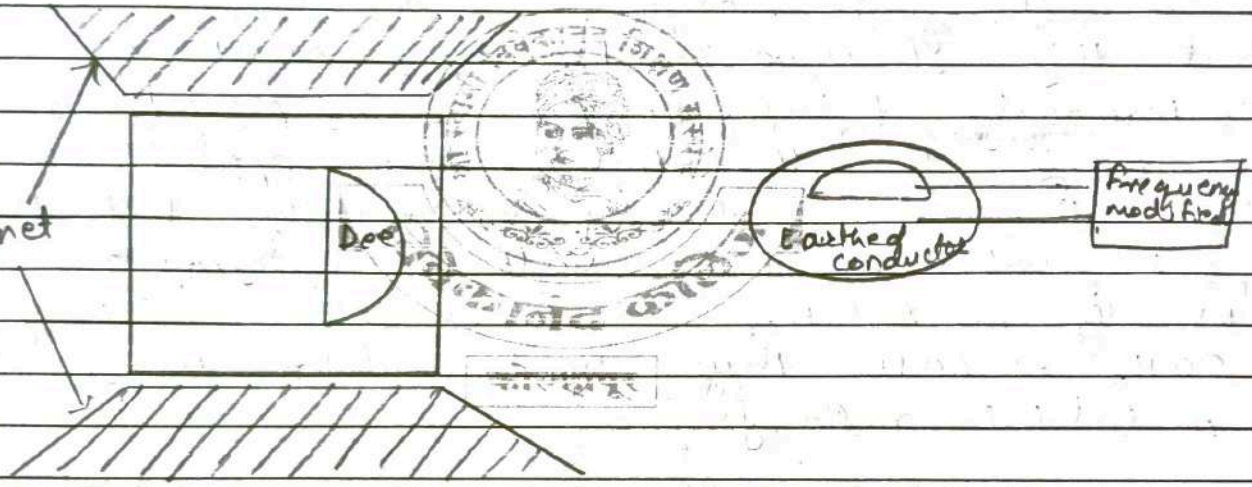
Subject : Nuclear and Particle Physics.

Test / Tutorial No. : Internal Exam

Div. :

Q1)

1)



Synchrocyclotron is basically a cyclotron with some modification viz,

1) The size of the dees is fairly large as maximum obtainable energy is very large & hence the pole-piece diameters are also very large.

2) Instead of simple radio frequency oscillator, the alternating voltage is obtained from a frequency modulated supply

In Berkely Synchrocyclotron, the modulated frequency is varied from 12.6 MHz to 7.0 MHz.

3) only one dee is used with an earthed conductor on the opposite side of opening the dee.

Working: To impart energy to the particle, the frequency of an alternating voltage between dees is decreased when the particle goes into a phase stable orbit characterised by a large radius with gain energy.
But this decrease in frequency must be done continuously & very slowly as compared to the frequency of alternating voltage applied to the dees decreases slowly & continuously, but the peak value of the voltage remains the same usually, modulation is done at 50 Hz or 60 Hz. Thus, syndrocyclotron uses a frequency modulated radio frequency.

Advantages of Synchrocyclotron

1) As it is based on the principal of phase stable orbit the relativistic mass increase is taken care of & therefore there is no need to restrict the no. of revolutions & hence the potential difference required between the dees may be very ~~small~~

2) Large electric fields in the gap required for focusing and accelerating the particles in cyclotron are number demanded so, usually only one dee

used This ample space is made available in the evacuated steel tank.

3) In Berkely 184 inch synchro cyclotron, the proton energies upto 300 MeV have been relised.

10

Q2.

1) The principal of principle of phase stable orbit

Consider a particle of relativistic mass

$$m = m_0\left(1 - \frac{v^2}{c^2}\right)^{-1/2}$$

and charge e, moving in an orbit of radius r, under the influence of magnetic field B

$$\frac{mv^2}{r} = Bev \quad \text{---------- (1)}$$

Angular velocity $\omega = \frac{v}{r} = \frac{Be}{m}$

The angular velocity $\left(\omega = \frac{2\pi}{T}\right)$ will be constant for particle with constant mass m, which is the principal of cyclotron.

$$\omega = \frac{Bec^2}{mc^2} = \frac{Bec^2}{m_0c^2 + E_K} \quad \text{---------- (2)}$$

where m_0c^2 is rest mass energy & E_K is kinetic energy of the particle.

Thus the angular velocity of the particle in a constant magnetic field decreases with increase in the kinetic energy & hence the phase relationship required for cyclotron principal will be upset. However a particle with a definite kinetic energy Ek will move in a stable orbit with constant angular velocity ω which is also the angular frequency of the alternating voltage between the dees. such an orbit where phase-stability is maintained.

Now it can be seen that the particle with a specific energy can be maintained in a phase-stable orbit, if every Ek will move in a stable orbit with constant angular velocity ω which is also the angular frequency of it, when the instantaneous potential difference across the dees is zero & about to become decelerating.

(3)

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 15/20

Roll No. : 8522

Class : B.Sc. Sem V

Subject : Nuclear and Particle physics

Test / Tutorial No. : Internal

Div. :

Synchrocyclotron –

Construction –

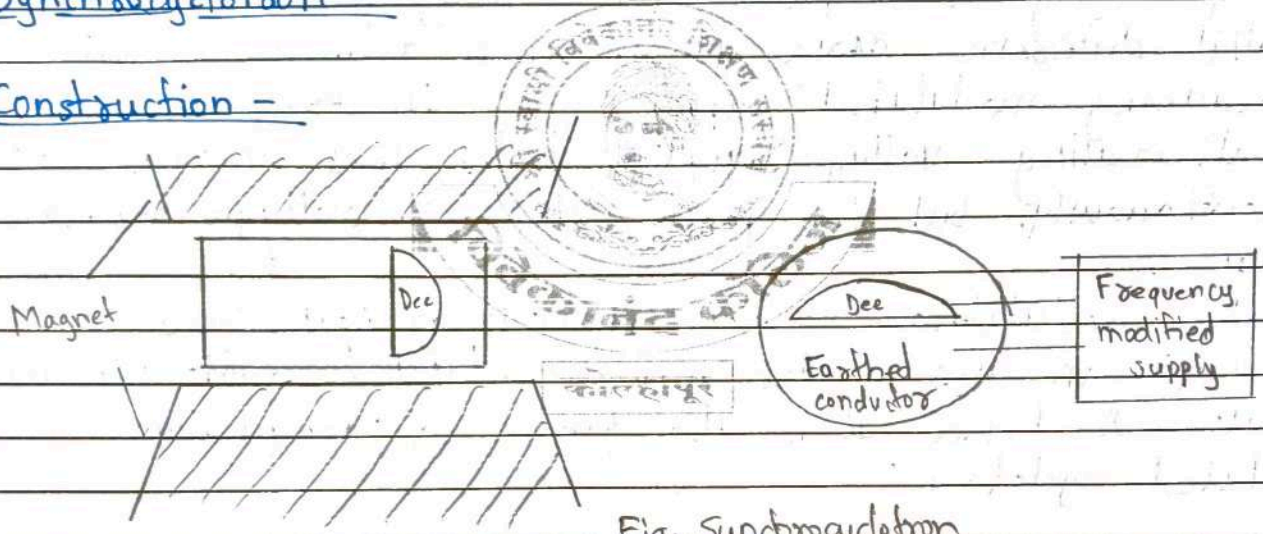

Fig. Synchrocyclotron

Synchrocyclotron is basically a cyclotron with some modifications viz.

1) The size of dees is fairly large as maximum obtainable energy is very large & hence the pole-piece diameters are also very large. Therefore, huge magnets weighing several tonnes are used.

2) Instead of simple radio frequency oscillator, the alternating voltage is obtained from a frequency modulated supply. In Berkeley synchrocyclotron, the modulated frequency is varied from 25 MHz to 9.0 MHz at a modulati

of 12 MHz.
5) Only one dee is used with an earthed conductor on the opposite side of opening of the dee as shown in the above fig.

Working -

① To impart energy to the particle, the frequency of an alternatively voltage between dees is decreased, when the particle goes into phase stable - orbit characterised by a large radius with gain in energy.

② But this decrease in frequency must be done continuously & very slowly as compared to frequency of alternating potential difference across dees. This is achieved by using a frequency modulated supply where in frequency of the alternating voltage applied to the dees decrease slowly & continuously, but the peak value of voltage remains the same.

③ Usually modulation is done at 50 Hz or 60 Hz. Thus synchrocyclotron uses a frequency modulated radio frequency oscillator & hence it is also known as 'frequency modulated cyclotron'.

Advantages

① As it is based on principle of phase-stable orbits, the relativistic mass increase is taken care of and therefore there is no need to restrict the no. of revolutions & hence the potential difference required bet^n dees may be very small. Usually it is about 15 kV at peak of alternating voltage.

② Large electric fields in gap required for focusing and accelerating particles in cyclotron are no longer demanded. So usually only 1 dee is used. Thus ample space is ma

available in eg evacuated steel tank for setting different targets or other apparatus.

(3) In Berkeley 184 inch sychrocyclotron the proton energies upto 300 MeV have been released.

Disadvantages -

(1) It can't be used to accelerate electron.

(2.6) Phase - stable Orbit Condition -

(1) Consider a particle of relativistic mass $m = M_0 \left(1 - \frac{V^2}{c^2}\right)^{-\frac{1}{2}}$ and charge e, moving in an orbit of radius r under the influence of magnetic field B.

$$\frac{mV^2}{r} = BeV \quad \text{---(1)}$$

$$\text{Angular velocity } \omega = \frac{V}{r} = \frac{Be}{m}$$

(2) The angular velocity $\left(\omega = \frac{2\pi}{T}\right)$ will be constant for particles with constant mass m, which is the principle of cyclotron. But when m increases relativistically then.

$$\omega = \frac{BeC^2}{mC^2} = \frac{BeC^2}{m_0c^2 + E_K} \quad \text{---(2)}$$

(3) when m_0c^2 is rest mass energy & E_K is kinetic energy of particle.

(4) Thus, the angular velocity of particle in constant magnetic field decreases with increase in kinetic energy & hence phase relationship required for cyclotron principle will be upset.

However, a particle with a definite kinetic energy E_K will move in stable orbit with constant angular velocity ω which is also angular frequency of

alternating voltage betⁿ dees.

(6) Such an orbit whose phase stability is maintained is called a phase-stable-orbit.

(7) Now it can be seen that the particle with specific ene: can be maintained in phase-stable-orbit if every time it crosses the gap between dees when the instantaneous potential difference across the dees is zero and about to become decelerating.

(5)

Vivekananda College Kolhapur (Autonomous).
Department of Physics: Internal examination 2018-19
B.Sc. III Semester V
Subject: Solid State Physics

Marks: 20 (Each question carry one mark) **Time : 20 min**

Q.1 Attempt any ONE **(10)**

1. Discuss Reciprocal lattice, Properties of reciprocal lattice.
2. Derive Bragg's law in reciprocal Lattice (Ewald's construction).

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

1. Define Powder method of X- ray diffraction.
2. Write a note on Miller indices
3. Derive packing fraction of HCP structure.

PRN No. 2015015500159146

कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR

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Information to be filled by Student
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Day and Date : Tuesday, 23-1-2018

Language of Answer : English

Examination : Internal Exam

Question Paper Code No : -

Subject : Physics

Paper No: XVI

Section : -

Q. No.	Examiner Marks	Moderator Marks
1		
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Total	25/25	
Signature		

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सूचना : विद्यापीठ नियमानुसार जो कोणी परिक्षा हॉलजवळ किंवा हॉलमध्ये पर्यवेक्षकांना किंवा परीक्षेसाठी नेमलेल्या कर्मचाऱ्यांना उत्तरपत्रिका, पुस्तक नोट्स किंवा अन्य विद्यार्थ्याच्या उत्तरपत्रिकेतून नक्कल करताना आढळून येईल किंवा जवळ परीक्षा गैरव्यवहारासाठी वापरता येईल असे अहितपार्ह साहित्य बाळगत असेल तर सदरची बाब परीक्षा प्रमाद मानून संबंधित व्यक्ति शिक्षेस पात्र राहील.

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Q. No.				TOTAL				TOTAL
Marks								

Q. No.

Que. 1.

i) a) 12

ii) a) a/2

iii) a) (6 4 3)

iv) c) reflection

v) b) inversely proportional to volume of unit cell of direct lattice

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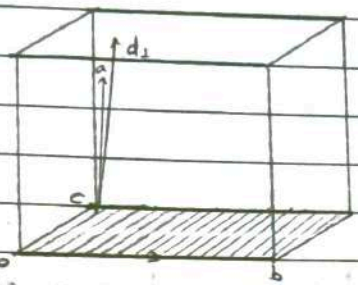
Q. No.				TOTAL				TOTAL
Marks								

Q. No.

Que. 2.

1) Relation between direct lattice and reciprocal lattice :-



The relation between direct lattice & reciprocal lattice can be calculated.

Let, V be the volume of unit cell.

Volume = Area (shaded region) x height

volume = area x d_1

$\therefore d_1 = \frac{\text{volume}}{\text{area}}$

$\therefore \frac{1}{d_1} = \frac{\text{area}}{\text{volume}}$

$\therefore \frac{\vec{n}}{d_1} = \frac{\vec{a}}{\vec{a}.(\vec{b}\times\vec{c})} \times \vec{\sigma}_{100}$

As $\vec{a}.(\vec{b}\times\vec{c})$ be the volume.

Q. No.

$$\therefore \sigma_{100} = \frac{\vec{b} \times \vec{c}}{\vec{a}\,(\vec{b} \times \vec{c})}$$

Reciprocal lattices are given by σ_{100}, σ_{010} & σ_{001} as they are denoted as a^*, b^* & c^*.

$$\therefore \quad a^* = \frac{\vec{b} \times \vec{c}}{\vec{a}\,(\vec{b} \times \vec{c})}$$

Similarly, $$b^* = \frac{\vec{c} \times \vec{a}}{\vec{a}\,(\vec{b} \times \vec{c})}$$

$$c^* = \frac{\vec{a} \times \vec{b}}{\vec{a}\,(\vec{b} \times \vec{c})}$$

This is the relation between direct lattice & reciprocal lattice.

Properties of reciprocal lattices :-

i) The reciprocal of reciprocal lattice is a direct lattice :-

The reciprocal lattice a^* is given by,

$$a^* = \frac{\vec{b} \times \vec{c}}{\vec{a}\,(\vec{b} \times \vec{c})}$$

we have to show,

$$(a^*)^* = a$$

Q. No.				TOTAL				TOTAL
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$$\therefore (a^*)^* = \frac{b^* \times c^*}{a^* \cdot (b^* \times c^*)} \quad \ldots (1)$$

We know that, $a \cdot a^* = 1$

Multiply eqn (1) by $a \cdot a^*$

$$\therefore (a^*)^* = a \cdot a^* \frac{b^* \times c^*}{a^* \cdot (b^* \times c^*)}$$

$$= a \cdot \frac{a^* \cdot (b^* \times c^*)}{a^* \cdot (b^* \times c^*)}$$

$$(a^*)^* = a$$

hence we proved this.

ii) The volume of unit cell in reciprocal lattice is the reciprocal of volume of unit cell in direct lattice :

To show : $a^* \cdot (b^* \times c^*) = \frac{1}{a \cdot (b \times c)}$

Proof :-

$$a^* \cdot (b^* \times c^*) = \left\{\frac{b \times c}{a \cdot (b \times c)}\right\}\left\{\frac{c \times a}{a \cdot (b \times c)}\right\}$$

$$\left\{\frac{a \times b}{a \cdot (b \times c)}\right\}$$

Q. No.

$$= \frac{1}{[a.(b\times c)]^3}.(b\times c)[(c\times a)(a\times b)]$$

$$= \frac{1}{[a.(b\times c)]^3}.(b\times c)[(c\times a).a - a.(a\times b)]$$

we know that,

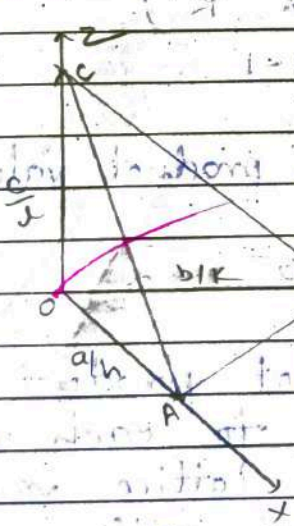
$$(c\times a).a = 0$$

$$\therefore a^*.(b^*\times c^*) = \frac{1}{[a.(b\times c)]^3}[a.(b\times c)]^2$$

$$\therefore a^*.(b^*\times c^*) = \frac{1}{a.(b\times c)}$$

That is the proof.

iii) Every reciprocal lattice vector is perpendicular to direct lattice



The intercept on x-axis is,

$$OA = \frac{\vec{a}}{h}$$

The intercept on y-axis is,

$$OB = \frac{\vec{b}}{k}$$

The intercept on z-axis is,

$$OC = \frac{\vec{c}}{l}$$

From diagram,

$$\frac{\vec{b}}{k} + \vec{B} = \frac{\vec{a}}{h}$$

$$\vec{B} = \frac{\vec{a}}{h} - \frac{\vec{b}}{k}$$

$\vec{B} \cdot \vec{\sigma}_{hkl}$ be the scalar product.

$$\vec{B} \cdot \vec{\sigma}_{hkl} = \left(\frac{\vec{a}}{h} - \frac{\vec{b}}{k}\right) \cdot (ha^* + kb^* + lc^*)$$

$$= 1 - 1$$

$$= 0$$

and this scalar product value is zero.

similarly,

$$\vec{A} \cdot \vec{\sigma}_{hkl} = 0$$

hence as their dot product is zero, that are perpendicular to each other.

i.e. Every reciprocal lattice vector is perpendicular to direct lattice.

PRN - 2015010055714255

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Information to be filled by Student
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Day and Date : 23-1-018

Language of Answer : English

Examination : B.Sc. III, Internal

Question Paper Code No :

Subject : Physics

Paper No:

Section :

Q. No.	Examiner Marks	Moderator Marks
1		
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Total	21/25	
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Q. No.				TOTAL				TOTAL
Marks								

Q. No. 1

1) The co-ordination no. of FCC lattice is 12

2) The atomic radius for simple cubic lattice is a/2

3) The Miller indices of a plane which cuts the intercept of 2, 3 & 4 unit along the three axes respectively are, 6 4 3

4) Diffraction of X-rays from the crystal is the phenomenon of ~~refraction~~ reflection.

5) The volume of unit cell of reciprocal lattice is inversely proportional to volume of unit cell of direct lattice.

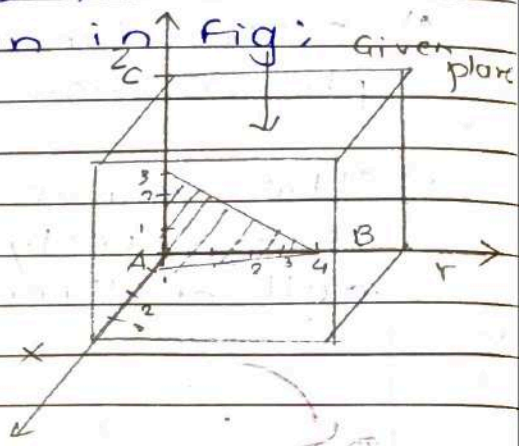
05

Q. No.				TOTAL				TOTAL
Marks								

Q. No. 9)

9) In a crystal plane are difine by giving ther orientation without giving position in space with reference to the direction of basis vector, plane has particular orientation, which may define by any three points of a plane, provided the points are not collinear

Consider a plane having plane ABC intercept one axial unit on x axis, four axial unit on Y axis & three axial unit on the z axis. shown in fig; The numerical parameter of the faces or plane are 4, 2, 3 these parameter taken as reciprocal of number These parameter are called as Miller Indices.



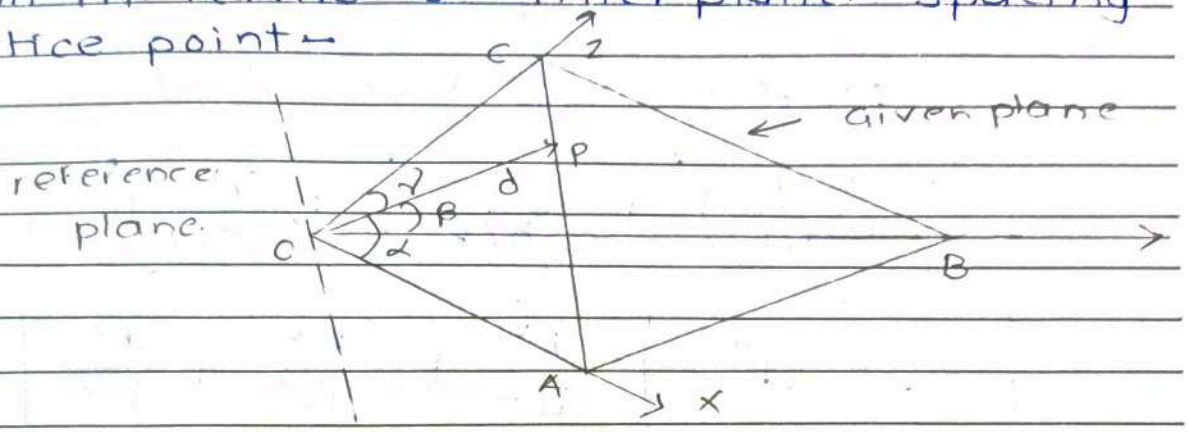
Axial length	4 A	8 A	3A
Intercept	1A	4 A	3A
Fractional intercept	$\frac{1}{4}$	$\frac{8}{4}$	$\frac{3}{3}$
reciprocal (Miller Indices)	4	2	1

Miller indices of ABC plane (4,2,1) denoted by h k l in paranthesis is

(h k l) = (4,2,1)

Q. No.

Realation in terms of interplaner spacing and lattice point:-



Consider the axis XYZ mutually perpendicular to each other.

Consider a reference plane passes through origin & next plane ABC cuts on the intercept a/h on X axis, b/k on Y axis and c/l on Z axis.

let d be perpendicular distance betⁿ reference plane & given plane.

let (h,k,l) be miller indices of given plane. let α be the angle betⁿ normal and OA, β be angle betⁿ normal & plane OB & γ be angle betⁿ normal & plane OC.

let $\cos\alpha$, $\cos\beta$, $\cos\gamma$ be the direction angle betⁿ of normal plane

by geometry in Δ AOBC,

$$\cos\alpha = \frac{d}{a/h}$$

$$\cos\beta = \frac{d}{b/k}$$

$$\cos\gamma = \frac{d}{c/l}$$

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Marks								

Q. No.

by using the property of triangle, trigonometry

$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$$

$$\therefore \left(\frac{d}{a/h}\right)^2 + \left(\frac{d}{b/k}\right)^2 + \left(\frac{d}{c/l}\right)^2 = 1$$

$$\therefore d^2\left[\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right] =$$

$$\therefore d^2 = \frac{1}{\left(\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right)}$$

$$\therefore \boxed{d = \frac{1}{\sqrt{\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}}}}$$

special case-

For cubic system,

$$a = b = c$$

$$\therefore d = \frac{1}{\sqrt{\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}}}$$

$$d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

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Day and Date : 23/1/2018

Language of Answer : English

Examination : BSc III, Internal

Question Paper Code No :

Subject : Physics

Paper No: Paper XVI

Section :

Q. No.	Examiner Marks	Moderator Marks
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Total	25	
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Q. No.				TOTAL				TOTAL
Marks								

Q. No.

Q-1

i) a) 12 ✓

ii) a) 9/2 ✓

iii) ~~a) (6, 4, 3)~~ a) (6 4 3) ✓

iv) a) scattering ✓

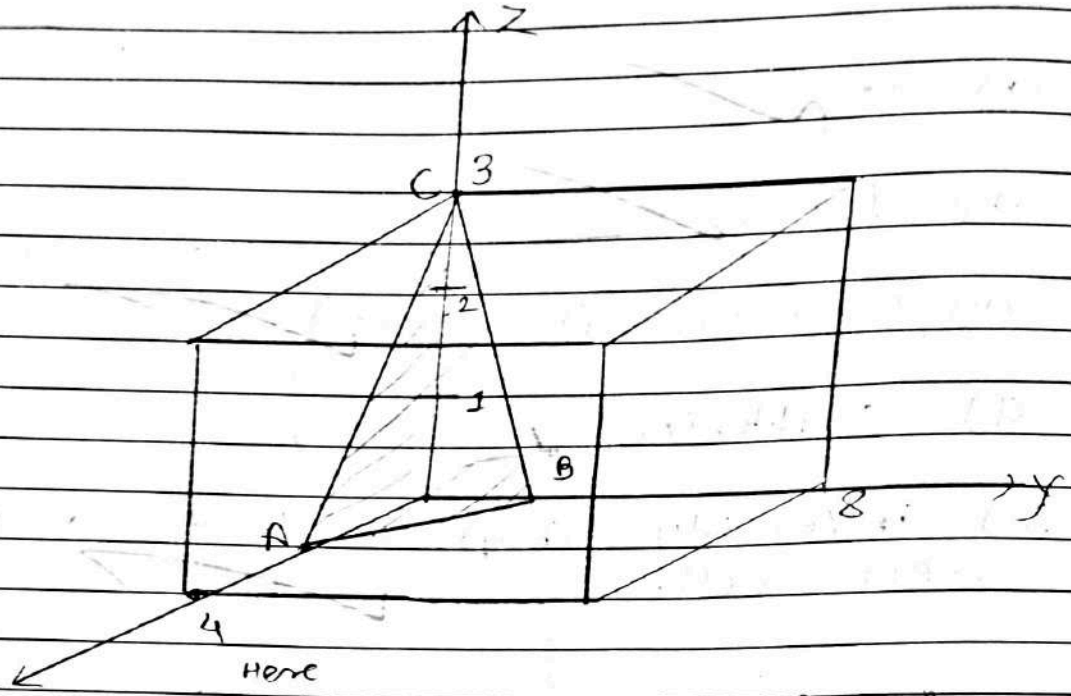
v) b) inversely proportional to volume of unit cell. ✓

a) h

Q. No.				TOTAL				TOTAL
Marks								

Q. No.

Q. 2.
ii)



Here
axial length 4Å, 8Å, 3Å

Defination:-

Orientation of a plane in a crystal can be described in terms of there reciprocal of intercept on a axis.

Consider a plane ABC having intercept one axial unit on x axis, 4 axial unit of y axis & 3 axial unit on z axis as shown in fig.

The numerical parameter of the plane are, 1, 4 & 3 but according to Miller it is more useful to denote or discribe this parameters by taking reciprocal it's numerical value.

This parameters are called as 'Miller indices.

Axial length	4 A	8 A	3 A
Intercept	1 A	4 A	3 A
Fractional intercept	$\frac{1}{4}$	$\frac{4}{8}$	$\frac{3}{3}$
Reciprocal miller indices.	4	2	1.

miller indices of ABC plane are (4 2 1) denoted by h k l that is

$$(h\ k\ l) \equiv (4\ 2\ 1)$$

Now. relation in terms of interplaner spacing and lattice parameters.

Q. No.				TOTAL				TOTAL
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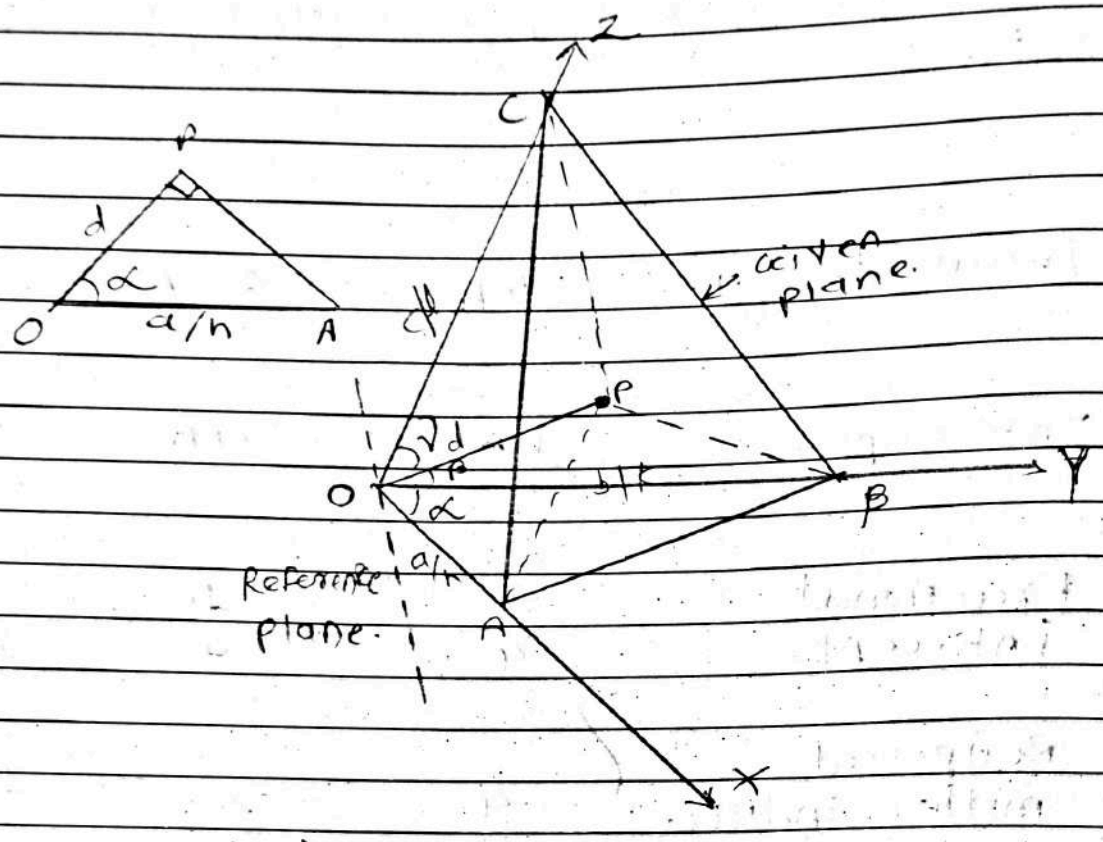
Q. No.



$\ell(OA) = a/h$

$\ell(OB) = b/k$

$\ell(OC) = c/l$

Consider the axis XYZ mutually perpandicular to each other.

Consider the reference plane passes through the origine & the other plane ABC cuts the plane intercept a/h on X axis. , b/k on Y axis. & c/l on Z axis. a normal AP is drawn to the plane ABC. From the origine.

Q. No.

Let, 'd' be the perpandicular distance betn reference plan & given plane.

Let, (h k l) miller indices of given plane ABC.

Let, α = be the angle betn normal & OA

β = angle betn normal & OB

γ = angle betn normal & OC.

Let $\cos\alpha$, $\cos\beta$, $\cos\gamma$ be the direction cosine of normal.

By using geometry,

$$\cos\alpha = \frac{d}{a/h}$$

$$\cos\beta = d/b/k$$

$$\cos\gamma = d/c/l$$

But $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

$$\left(\frac{d}{a/h}\right)^2 + \left(\frac{d}{b/k}\right)^2 + \left(\frac{d}{c/l}\right)^2 = 1$$

Q. No.				TOTAL				
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Q. No.

$$\frac{d^2h^2}{a^2} + \frac{d^2k^2}{b^2} + \frac{d^2l^2}{c^2} = 1$$

$$d^2\left[\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right] = 1$$

$$d^2 = \frac{1}{\left[\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right]}$$

$$\boxed{d = \frac{1}{\sqrt{\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}}}}$$

this is the relation betⁿ interplanar distance & miller indices.

Case1:-

For cubical System

$$a = b = c$$

$$\therefore d = \frac{1}{\sqrt{\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}}}$$

$$d = \frac{1}{\sqrt{\frac{h^2+k^2+l^2}{a^2}}}$$