CODE NO: 00000

T.I. MATRICULATION HIGHER SECONDARY SCHOOL, AMBATTUR

Half Yearly Examination-December 2018

MARKS: 70

TIME : 2 ½ hours

SCORING KEY

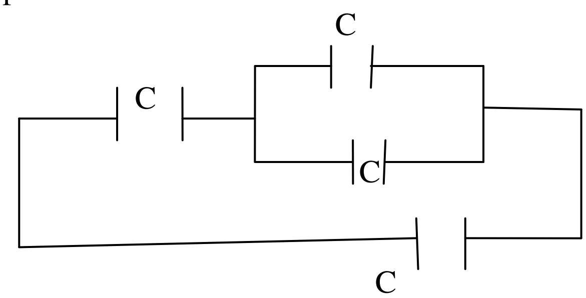
Class:XII **Date:10.12.18**

subject :PHYSICS

PART A

I.Choose the correct answer ***(15x1=15)***

1. Out of the following, which is not emitted by a radioactive substance ?
   a.electrons b.EM radiation **c. neutrons**
   d.He nuclei with a charge equal to that of 2 protons
2. In amplitude modulation, if signal amplitude and carrier amplitude are equal, then the amplitude of LSB is
   a.E_c **b. E_c /2** c.$\omega_c - \omega_s$ d. $\omega_c + \omega_s$
3. If the energy of the electromagnetic wave is 'E' then the energy associated with electric field vector
   a. E b. 2E c. E/4 **d. E/2**
4. The value of Planck's constant is
   a. 6.625 x 10^{34} Js **b. 6.625 x 10^{-34} Js** c. 66.25 x 10^{34} Js
   d. 6.025 x 10^{23} Js
5. Four equal capacitors each of capacitance C are arranged as shown. The effective capacitance between A and B is



   a.(5/8) C b.(3/5) C **c.(5/3)C** d.C
6. In a potentiometer arrangement , a cell of emf 1.25 V gives a balance point at 35 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63 cm, what is the emf of 2 nd cell?
   a.0.7 V **b.2.25 V** c. 0.4 V d. 1 V
7. For transmission of audio and video signals, the required frequency range of radio waves is between _________.
   a. 50 Hz and 100 Hz b. 400 KHz and 500 KHz
   c. 400 Hz and 800 Hz **d. 100 KHz to 100 MHz**
8. The ratio of secondary to the primary turns in a transformer is 3:2. If the power output be P, then the input power (neglecting all losses) must be equal to
   a.5P b.1.5 P **c.P** d.2/5 P

9. Two photons,each of energy 2.5 eV are simultaneously incident on the metal surface. If the Work function of the metal is 4.5 eV, then from the surface of the metal how many electrons will be emitted ?

a.one electron | b.two electron | c.more than two electrons

d. not a single electron

10. Radioactive substances x and y contain equal number of atoms initially. Half life of x and y are 1 day and 2 days respectively. At the end of 2^{nd} day , the ratio of rate of disintegration of x and y is

a.1:2 | b.2:1 | c.1:1 | d.1:4

11. When an electron jumps from M shell to the K shell it gives

a.K_α line | **b.K_β line** | c.L_α line | d.L_β line

12. In which of the following pairs of metals of the thermocouple the emf is Maximum?

a. Fe-Cu | b. Cu-Zn | c. Pt-Ag | **d.. Sb-Bi**

13. In an AM super heterodyne receiver, the local oscillator frequency is 1.245 MHz. The tuned station frequency is

a.455 kHz | **b.790 kHz** | c.690 kHz | d.990 kHz

14. An electron and a proton have the same amount of kinetic energy. Which of the two possesses greater wavelength?

a.electron | b.proton | c. both | d. none

15. Three resistors with resistance 2 Ω, 3 Ω and 5 Ω respectively are connected in series with 10 V battery. Calculate the equivalent resistance and current that passes through each resistor

a. **10 Ω, 1 A** | b.10 Ω ,10 A | c 1Ω,1 A | d.1 Ω,10 A

PART B

II Answer any SIX of the following. Q.No. 18 is compulsory. (6x2=12)

16. Why ordinary plane transmission gratings cannot be used to produce diffraction effects in X-rays?

Attempts were made to measure the wave length of X-rays by means of diffraction gratings which proved unsuccessful, as the grating failed to disperse X–rays on account of their very small wavelength

Obviously, diffraction effects can only be observed if the spacing between the lines ruled on the grating is of the order of magnitude of wavelength of the wave used. Thus, in order to diffract X–rays, grating with much finer rulings, having distance between rulings comparable to the wave length of X–rays are required. It is impossible to construct a grating of such fine dimensions artificially.

2 marks

17. Draw circuit diagram of Colpitt oscillator

Circuit **Diagram** **2 marks**

18. When a nucleus (x) undergoes β decay and transform to the nucleus (y), does the pair (x,y) form isotopes, isobars or isotones ?Justify your answer.

Isobar . X and Y will have the same mass number which is Isobar.

2 marks

19. A carrier wave of peak voltage 18 V is used to transmit a message signal. Calculate the peak voltage of the modulating signal in order to have a modulation factor 50 %.

m= 50 %
E_c = 18 V
E_s =?
m= E_s / E_c
E_s = E_c x m
= 18 x 50 /100
= 9 V

2 marks

20. How will you represent a resistance of 3700 Ω ∓ 10% by colour code?

Orange violet red silver **2 marks**

21. Why is the interference pattern not detected when the two coherent sources are far apart?

we know that β =λ D/d or βα 1/d **1 mark**

If d is large, then β is very small. So interference pattern is not detected

1 mark

22. State Coulomb's law in electrostatics.

Coulomb's law states that the force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. The direction of forces is along the line joining the two point charges

2 marks

23. Two ions having masses in the ratio 1:1 and charges 1:2 are projected into uniform magnetic field perpendicular to the field with speeds in the ratio 2:3. Find the ratio of the radii of circular paths along which the two particles move.

R=mv/Bq **1 mark**

$R_1 / R_2 = m_1 v_1 q_2 / m_2 v_2 q_1$

=1x2x2/1x3x1 =4/3 **1 mark**

24. Mention the uses of electron microscope

(i)It is used in the industry, to study the structure of textile fibres, surface of metals, composition of paints etc.
(ii) In medicine and biology, it is used to study virus, and bacteria.
(iii) In Physics, it has been used in the investigation of atomic structure and structure of crystals in detail.

2 marks

PART C

III Answer any SIX of the following . Q.No.31 compulsory. ***(6x3=18)***

25. State and prove de Morgan's theorem.

The two De Morgan's theorems are very important in dealing with NOR and NAND gates. They state that a NOR gate that performs the A B + function is equivalent to the function A .B and NAND gate, that performs the A B . function is equivalent to the function A +B .

First theorem "The complement of a sum is equal to the product of the complements." If A and B are the inputs, then $\overline{A+B} = \overline{A}.\overline{B}$

1 mark

Second theorem "The complement of a product is equal to the sum of the complements." If A and B are the inputs, then . then $\overline{A.B} = \overline{A}+\overline{B}$

1 mark

Truth table to prove De–Morgan's theorems **1 mark**

26. A proton and an α particle are accelerated through the same potential. Which one of the two has greater value of de-Broglie wavelength associated with it.

λ= h/$\sqrt{2mVq}$

since potential is same

λ α 1/$\sqrt{mq}$ **or**

λ a /λ p = $\sqrt{\frac{mass\ of\ proton\ x\ charge\ of\ proton\ (mp\ \ qp)}{mass\ of\ alpha\ x\ charge\ of\ alpha\ (ma\ \ qa)}}$ **1 mark**

As charge on alpha particle = 2 x charge on proton

qa**= 2 x** qp

$q_a / q_p = 2$

mass of alpha particle = 4 x mass of proton

$m_a = 4 \times m_p$

$m_a / m_p = 4$

λ a /λ p = $\sqrt{\frac{1}{4.2}}$ **1 mark**

λ a = 2 $\sqrt{2}$ **/λ p** **1 mark**

27. Two bulbs consume same power when operated at 200 V and 300 V respectively. When these bulbs are connected in series across a DC source of 500 V, then what is the ratio of potential difference across them?

$P=V^2/R$

$R=V^2/P$ **1 marks**

$R \ \alpha \ V^2$

$R_1 / R_2 = (200/300)^2 = 4/9$ **1 marks**

When connected in series potential drop and power consumed are in the ratio of their resistances, So

$P_1/P_2 = V_1/V_2 = R_1/R_2 = 4/9$ **1 marks**

28. Name the radiations of electromagnetic spectrum which are used in
(i)warfare to look through fog (ii)radar and geostationary satellite
(iii)studying the structure and properties of atoms and molecules

Infrared

Microwaves and

x- rays **3x1=3 marks**

29. Write the applications of Super conductors

(i)Superconductors form the basis of energy saving power systems, namely the superconducting generators, which are smaller in size and weight, in comparison with conventional generators.
(ii)Superconducting magnets have been used to levitate trains above its rails. They can be driven at high speed with minimal expenditure of energy.
(iii)Superconducting magnetic propulsion systems may be used to launch satellites nto orbits directly from the earth without the use of rockets.
(iv) High efficiency ore–separating machines may be built using superconducting magnets which can be used to separate tumor cells from healthy cells by high gradient magnetic separation method.
(v) Since the current in a superconducting wire can flow without any change in magnitude, it can be used for transmission lines.
vi) Superconductors can be used as memory or storage elements in computers

3 marks

30. What are the properties of neutron

Neutrons are the constituent particles of all nuclei, except hydrogen.

Neutrons are neutral particles with no charge and mass slightly greater than that of protons. Hence, they are not deflected by electric and magnetic fields

Neutrons are stable inside the nucleus. But outside the nucleus they are unstable. The free neutron decays with an emission of proton, electron and antineutrino, with half life of 13 minutes. 0n1 → 1H1 + −1e0 + ν

As neutrons are neutral, they can easily penetrate any nucleus.
Neutrons are classified according to their kinetic energy as (a) slow neutrons and (b) fast neutrons. Both are capable of penetrating a nucleus causing artificial transmutation of the nucleus. Neutrons with energies from 0 to 1000 eV are called slow neutrons. The neutrons with an average energy of about 0.025 eV in thermal equilibrium are called thermal neutrons
Neutrons with energies in the range
between 0.5 MeV and 10 MeV are called fast neutrons. In nuclear reactors, fast neutrons are converted into slow neutrons using moderators.

3 marks

31. When 1×10^{12} electrons are transferred from one conductor to another, a potential difference of 10 V appears between the conductors. Find the capacitance of the two conductors.

$n = 1 \times 10^{12}$

$V = 10$ V

$e = 1.6 \times 10^{-19}$ C

$C = q/V = ne/V = 1 \times 10^{12} \times 1.6 \times 10^{-19} / 10 = 1.6 \times 10^{-8}$ F

3x 1=3 marks

32. State and derive Braggs law

W.L. Bragg and W.H. Bragg studied the diffraction of X–rays in detail and used a crystal of rock salt to diffract X–rays and succeeded in measuring the wavelength of X– rays

Consider homogeneous X–rays of wave length λ incident on a crystal at a glancing angle θ. The incident rays AB and DE after reflection from the lattice planes Y and Z travel along BC and EF respectively as shown in Fig 6.18. Let the crystal lattice spacing between the planes be d. BP and BQ are perpendiculars drawn from B on DE and EF respectively.

1 /2 mark

Therefore, the path difference between the two waves ABC and DEF is equal to PE + EQ.
In the ∆PBE, sin θ =PE /BE
(or) PE = BE sin θ = d sin θ
in the ∆QBE, sin θ = EQ BE
(or) EQ = BE sin θ = d sin θ

∴ Path difference = PE + EQ = d sinθ + d sinθ = 2d sinθ

Derivation **1 mark**

If this path difference 2d sin θ is equal to integral multiple of wavelength of X-ray i.e. n λ , then constructive interference will occur between the reflected beams and they will reinforce with each other. Therefore the intensity of the reflected beam is maximum. ∴ 2d sin θ = n λ where, n = 1, 2, 3 … etc. This is known as Bragg's law.

1 mark

Diagram **1 /2 mark**

33. What are the special features of magnetic Lorentz force?

Let us consider a uniform magnetic field of induction B acting along the Z-axis. A particle of **charge + q moves with a velocity *v* in YZplane making an angle θ with the direction of the field .**

Under the influence of the field, the particle experiences a force F.H.A.Lorentz formulated the special features of the force F (Magnetic lorentz force) as under :

(i) the force F on the charge is zero, if the charge is at rest. (i.e) the moving charges alone are affected by the magnetic field.

(ii) the force is zero, if the direction of motion of the charge is either parallel or anti-parallel to the field and the force is maximum,when the charge moves perpendicular to the field.

(iii) the force is proportional to the magnitude of the charge (q)

(iv) the force is proportional to the magnetic induction (B)

(v) the force is proportional to the speed of the charge (v)

(vi) the direction of the force is oppositely directed for charges of opposite sign

All these results are combined in a single expression as

$$\vec{F} = q(\vec{v} \times \vec{B})$$

The magnitude of the force is

$$F = Bqv \sin\theta$$

Since the force always acts perpendicular to the direction of motion of the charge, the force does not do any work.

In the presence of an electric field E and magnetic field B, the total force on a moving charged particle is

$$\vec{F} = q[(\vec{v} \times \vec{B}) + \vec{E}]$$

3 marks

PART D

IV. Answer the following questions ***(5x5=25)***

34. Describe the principle, construction and working of Geiger-Muller counter.

Geiger – Muller counter is used to measure the intensity of th eradioactive radiation. When nuclear radiations pass through gas,ionisation is produced. This is the principle of this device.

1 mark

The G.M tube consists of a metal tube with glass envelope (C) acting as the cathode and a fine tungsten
wire (W) along the axis of the tube, which acts as anode The tube is well insulated from the anode wire
The tube is filled with an inert gas like argon at a low pressure. One end is fitted with a thin mica
sheet and this end acts as a window through which radiations enter the tube. A high potential difference of about 1000 V is applied between the electrodes through a high resistance R of about 100 mega ohm.

1 mark

Operation

When an ionising radiation enters the counter, primary ionisation takes place and a few ions are produced. These ions are accelerated with greater energy due to the high potential difference and they cause further ionisation and these ions are multiplied by further collisions. Thus an avalanche of electrons is produced in a short interval of time. This avalanche of electrons on reaching the anode generates a current pulse, which when passing through R develops a potential difference. This is amplified by electronic circuits and is used to operate an electronic counter. The counts in the counter is directly proportional to the intensity of the ionising radiation.The ionisation of the gas is independent of the type of the incident radiation. Hence, G.M. counter does not distinguish the type of radiation that enters the chamber.

2 marks

Diagram **1 mark**

OR

Discuss the theory of plane transmission grating

An arrangement consisting of a large number of equidistant parallel narrow slits of equal width separated by equal opaque portions is known as a diffraction grating. The plane transmission grating is a plane sheet of transparent material on which opaque rulings are made with a fine diamond pointer. The modern commercial form of grating contains about 6000 lines per centimetre. The rulings act as obstacles having a definite width 'b' and the transparent space between the rulings act as slit of width 'a'. The combined width of a ruling and a slit is called grating element (e). Points on successive slits separated by a distance equal to the grating element are called corresponding points.

1 mark

Theory MN represents the section of a plane transmission grating. AB, CD, EF … are the successive slits of equal width a and BC, DE … be the rulings of equal width b

Let e = a + b. Let a plane wave front of monochromatic light of wave length λ be incident normally on the grating. According to Huygen's principle, the points in the slit AB, CD … etc act as a source of secondary wavelets which spread in all directions on the other side of the grating. Let us consider the secondary diffracted wavelets, which makes an angle θ with the normal to the grating.

The path difference between the wavelets from one pair of corresponding points A and C is CG = (a + b) sin θ. I

t will be seen that the path difference between waves from any pair of corresponding points is also (a + b) sin θ

The point P1 will be bright, when (a + b) sin θ = m λ where m = 0, 1, 2, 3 In the undiffracted position θ = 0 and hence sin θ = 0. (a + b) sin θ = 0, satisfies the condition for brightness for m = 0. Hence the wavelets proceeding in the direction of the incident rays will produce maximum intensity at the centre O of the screen. This is called zero order maximum or central maximum.

If (a + b) sin θ1 = λ, the diffracted wavelets inclined at an angle θ1 to the incident direction, reinforce and the first order maximum is obtained.

Similarly, for second order maximum, (a + b) sin θ2 = 2λ On either side of central maxima different orders of secondary maxima are formed at the point P1, P2. In general, (a + b) sin θ = m λ is the condition for maximum intensity, where m is an integer, the order of the maximum intensity

sin θ = m λ /a+b or sin θ = Nmλ

where N = 1/ a +b , gives the number of grating element or number of lines per unit width of the grating. When white light is used, the diffraction pattern consists of a white central maximum and on both sides continuous coloured images are formed.

3 marks

in the undiffracted position, θ = 0 and hence sin θ = 0. Therefore sin θ = Nmλ is satisfied for m= 0 for all values of λ. Hence, at O all the wavelengths reinforce each other producing maximum intensity for all wave lengths. Hence an undispersed white image is obtained.
As θ increases, (a + b) sin θ first passes through 2 λ values for all colours from violet to red and hence darkness results. As θ further increases, (a + b) sin θ passes through λ values of all colours resulting in the formation of bright images producing a spectrum from violet to red. These spectra are formed on either side of white, the central maximum.

Diagram **1 mark**

35. Discuss with theory the method of inducing emf in coil by changing its orientation with respect to the direction of the magnetic field

PQRS is a rectangular coil of N turns and area A placed in a uniform magnetic field B (Fig 4.10). The coil is rotated with an angular velocity ω in the clockwise direction about an axis perpendicular to the direction of the magnetic field. Suppose, initially the coil is in vertical position, so that the angle between normal to the plane of the coil and magnetic field is zero. After a time t, let θ (=ωt) be the angle through which the coil is rotated. If φ is the flux linked with the coil at this instant, then φ = NBA cos θ

1 mark

The induced emf is,
e=–dφ/ dt
= −NBAd/ cos (ωt)

dt

∴ e = NBAω sin ωt ...(1)

The maximum value of the induced emf is, Eo = NABω Hence, the induced emf can be represented as e = Eo sin ωt The induced emf e varies sinusoidally with time t and the frequency being ν cycles per second (ν=ω /2π)

1 mark

Diagram **1 ½ marks**

(i) **When ωt = 0, the plane of the coil is perpendicular to the field B and hence e = 0.**

(ii) **(ii) When ωt = π/2, the plane of the coil is parallel to B and hence e = Eo**

(iii) **(iii) When ωt = π, the plane of the coil is at right angle to B and hence e = 0.**

(iv) **(iv) When ωt = 3π/2, the plane of the coil is again parallel to B and the induced emf is e = −Eo.**

(v) **(v) When ωt = 2π, the plane of the coil is again perpendicular to B and hence e = 0. If the ends of the coil are connected to an external circuit through a resistance R, current flows through the circuit, which is also sinusoidal in nature. 4.4 AC generator (Dynamo) – Single phase The ac generator is a device used for converting mechanical**

1 ½ marks

OR

What is feedback?Derive an expression for voltage gain of an amplifier with negative feedback.

The characteristics of an amplifier are highly dependent on transistor parameters like current gain, input impedance and output impedance etc. The transistor parameters exhibit variations due to ageing of transistors. Manufacturing processes cause variations in parameters of transistors of the same type. To overcome any adverse effect on the overall performance of an amplifier, feedback is used. Feedback is said to exist in an amplifier circuit, when a fraction of the output signal is returned or fed back to the input and combined with the input signal. If the magnitude of the input signal is reduced by the feed back, the feed back is called negative or degenerative. If the magnitude of the input signal is increased by the feed back, such feed back is called positive or regenerative.

1 mark

Principle of feedback amplifier For an ordinary amplifier i.e. without feedback, let V0 and Vi be the output voltage and input voltage respectively. If A be the voltage gain of the amplifier, then A = 0

The gain A is often called as open–loop gain. The general theory of feedback can be explained with the help of block diagram shown in Fig 9.39. The feedback amplifier has two parts (i.e) amplifier and feedback circuit. The feedback circuit usually consists of passive components (resistor, capacitor, inductor). A fraction (say β) of the output voltage is fed back to the input through the feedback circuit. Let V ′o be the output voltge with feedback.

1 mark

Therefore, after feedback the input voltage V ′i becomes,

V ′i = V i + βV ′o ... (1)

For positive feedback, β is taken as positive. For negative feedback, β is taken as negative. For positive feedback, the input voltage will be Vi + βV ′o. When this is amplified A times by the amplifier, the output voltage after feedback

(V ′o) will be A(Vi + βV ′o)

∴ V ′o = A (Vi + βV ′o) ... (2)

V ′o (1– βA) = AVi ... (3)

Then the voltage gain of the amplifier with feedback is
Af = V_0'/V_i A / 1- A β ...(4)
Since
|1 – β A| < 1, $A_f > A$

The positive feedback increases the amplifier gain.

For negative feedback, the feedback fraction is – β
∴ Af = V_0'/V_i A / 1+ A β

Since
|1 + β A| > 1, $A_f < A$

Derivation 2 mark

Therefore negative feedback reduces the amplifier gain. The term Aβ is called loop gain and β is called feedback ratio.

Diagram 1 mark

36. Obtain an expression for the current in an ac circuit containing a pure inductance. Find the phase relationship between voltage and current.

Let an alternating source of emf be applied to a pure inductor of inductance L. The inductor has a negligible resistance and is wound on a laminated iron core. Due to an alternating emf that is applied to the inductive coil, a self induced emf is generated which opposes the applied voltage. (eg) Choke coil.
1 mark

Diagram(circuit, graph, phasor diagram) 1 ½ marks

The instantaneous value of applied emf is given by
e = Eo sin ωt ...(1)
Induced emf e′ = −L . di /dt where

L is the self inductance of the coil. In an ideal inductor circuit induced emf is equal and opposite to the applied voltage
Therefore e = −e′
Eo sin ωt = = −(- L . di /dt)
Eo sin ωt = = L . di /dt

$di = (E_0/ L) \sin \omega t\, dt$
Integrating both the sides
$i = (E_0/ L) \int \sin \omega t\, dt$

$i = (E_0/ L) \int \sin \omega t\, dt$
$i = (E_0/ L) [-\cos \omega t/ \omega]$

$i = (E_0 /L \omega) \sin (\omega t- \pi /2)$
$i= I_0 \sin (\omega t- \pi /2)$ ………. (2)

where $I_o = E_0/ L \omega$. Here, ωL is the resistance offered by the coil. It is called inductive reactance. Its unit is ohm .

1 ½ marks

From equations (1) and (2) it is clear that in an a.c. circuit containing a pure inductor the current i lags behind the voltage e by the phase angle of π/2. Conversely the voltage across L leads the current by the phase angle of π/2. This fact is presented graphically in Fig. The phasor diagram of a.c. circuit containing only L is drawn.

½ mark

Inductive reactance $X_L = \omega L = 2\pi \nu L$, where ν is the frequency of the a.c. supply
For d.c. ν = 0; ∴ $X_L = 0$ Thus a pure inductor offers zero resistance to d.c. But in an a.c. circuit the reactance of the coil increases with increase in frequency.

½ mark

OR

(i)The equivalent resistance of eight resistances in series is 48 Ω. What would be the equivalent resistance if they are connected in parallel?

$1/R_p = n/R$ **1/2mark**

$R_p = R/n$
$R_s = nR$ **1/2mark**

48=8xR R=6 **1/2 mark**

$R_p = R/n$
$R_p = 6/8$
= ¾ Ω **½ +1/2 mark**

(ii) An electric bulb draws a current of 0.2 A when the voltage is 220 volt. Calculate the amount of electric charge flowing through it in one hour.

Q=I x t **½ mark**
Q=0.2 x1x 3600 **1 mark**
Q=720 C **½+1/2 mark**

37. Draw a neat sketch of ruby laser and explain its working with the help of energy level diagram.

The Ruby laser was first developed by T.Maiman in 1960. It consists of a single crystal of ruby rod of length 10 cm and 0.8 cm in diameter. A ruby is a crystal of aluminium oxide Al_2O_3, in which some of aluminium ions (Al^{3+}) are replaced by the chromium ions (Cr^{3+}). The opposite ends of ruby rod are flat and parallel; one end is fully silvered and the other is partially silvered (i.e.) semi transparent. The ruby rod is

surrounded by a helical xenon flash tube which provides the pumping light to raise the chromium ions to upper energy level . In the xenon flash tube, each flash lasts several milliseconds and in each flash a few thousand joules of energy is consumed.

1 mark

The simplified energy level diagram of chromium ions in a ruby laser, indicating appropriate excitation and decay is shown .In normal state, most of the chromium ions are in the ground state E1.When the ruby rod is irradiated by a flash of light, the 5500 Å radiation(green colour) photons are absorbed by the chromium ions which are pumped to the excited state E3.The excited ion gives up part of its energy to the crystal lattice and decay without giving any radiation to the meta stablestate E2. Since, the state E2 has a much longer lifetime (10-3s), the number of ions in this state goes on increasing. Thus population inversion is achieved between the states E2 and E1. When the excited ion from the metastable state E2 drops down spontaneously to the ground state E1, it emits a photon of wavelength 6943 Å. This photon travels through the ruby rod and is reflected back and forth by the silvered ends until it stimulates other excited ion and causes it to emit a fresh photon in phase with stimulating photon. Thus the reflections will amount to the additional stimulated emission – the so called amplification by stimulated

2 marks

Diagram ½ marks

Energy diagram 1 ½ marks

OR

Analyse the amplitude modulated wave and discuss its frequency spectrum and Bandwidth.

A carrier wave may be represented as,
ec = Ec cos ω ct ... (1)
where ec, Ec and ω c represent the instantaneous voltage, amplitude and angular frequency of the carrier wave respectively.

In amplitude modulation, the amplitude Ec of the carrier wave is varied in accordance with the intensity of the audio signal as shown in Fig 10.5.
The modulating signal may be represented as, es = Es cos ω st ... (2)

where es, Es and ω s represent instantaneous voltage, amplitude and angular frequency of the signal respectively. Amplitude modulated wave is obtained by varying Ec of equation (1) in accordance with Es. Thus, amplitude modulated wave is,

1 mark

Derivation 1 ½ marks

3 components 1 mark

Frequency spectrum diagram & channel width ½ mark

The lower side band term and upper side band term are located in the frequency spectrum on either side of the carrier at a frequency interval of ω*s* as shown in Fig 10.7. The magnitude of both the upper and lower side bands is *m*/2 times the carrier amplitude *Ec*. If the modulation factor *m* is equal to unity, then each side band has amplitude equal to half of the carrier amplitude.

Bandwidth

In an AM wave, the bandwidth is from *(ωc – ωs)* to *(ωc + ωs)* i.e twice the signal frequency. In the preceding section, it is assumed that the modulating signal is composed of one frequency component only. However, in a broadcasting station, the modulating signal is the human voice or music which contains waves with a frequency range of 300 – 3000 Hz. Each of these waves has its own side bands. The upper side band (USB), in fact, contains all sum components of the signal and carrier frequency whereas lower side band (LSB) contains the difference

1 mark

38. Describe the principle, construction and working of cyclotron

Cyclotron is a device used to accelerate charged particles to high energies. It was devised by Lawrence.

Cyclotron works on the principle that a charged particle moving normal to a magnetic field experiences magnetic lorentz force due to which the particle moves in a circular path.

1 mark

It consists of a hollow metal cylinder divided into two sections D1 and D2 called Dees, enclosed in an evacuated chamber (Fig 3.21). The Dees are kept separated and a source of ions is placed at the centre in the gap between the Dees. They are placed between the pole pieces of a strong electromagnet. The magnetic field acts perpendicular to the plane of the Dees. The Dees are connected to a high frequency oscillator

1 mark

When a positive ion of charge *q* and mass *m* is emitted from the source, it is accelerated towards the Dee having a negative potential at that instant of time. Due to the normal magnetic field, the ion experiences magnetic lorentz force and moves in a circular path. By the time the ion arrives at the gap between the Dees, the polarity of the Dees gets reversed. Hence the particle is once again accelerated and moves into the other Dee with a greater velocity along a circle of greater radius. Thus the particle moves in a spiral path of increasing radius and when it comes near the edge, it is taken out with the help of a deflector plate (D.P). The particle with high energy is now allowed to hit the target T. When the particle moves along a circle of radius *r* with a velocity *v*, the magnetic Lorentz force provides the necessary centripetal force.

1 mark

Derivation and final equation **1 1/2 mark**

Diagram **½ mark**

OR

Derive an expression for the electric potential at a point due to an electric dipole. Discuss the special cases.

Two charges –q at A and +q at B separated by a small distance 2d constitute an electric dipole and its dipole moment is p (Fig 1.13). Let P be the point at a distance r from the midpoint of the dipole O and θ be the angle between PO and the axis of the dipole OB. Let r1 and r2 be the distances of the point P from +q and –q charges respectively.

Potential at P due to charge (+q) = $1/4\pi \epsilon_0$ $(1/r_1)$

Potential at P due to charge (−q) = $1/4\pi \epsilon_0$ $(1/r_2)$ **1 mark**

Derivation **2 marks**

Diagram **1 mark**

Final equation and conclusion **½ +1/2 mark**