Version No.			

ROLL NUMBER						

Answer Sheet No._____

Sign. of Candidate _____

Sign. of Invigilator _____

PHYSICS HSSC–II (3rd Set)

SECTION – A (Marks 17)

Time allowed: 25 Minutes

Section – A is compulsory. All parts of this section are to be answered on this page and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. **Do not use lead pencil.**

Q.1 Fill the relevant bubble for each part. Each part carries one mark.

(1) Two charges q_1 and q_2 are placed in vacuum at a distance d and force between them is F. If a medium of relative permittivity 4 is introduced between them then new force will be:

A. $\frac{F}{4}$ ◯ B. $\frac{F}{2}$ ◯

C. 2F ◯ D. 4F ◯

(2) Three capacitors of 4μF each are connected in such a way that net capacitance of their combination is 6μF. It is possible if:

A. All the three in series ◯

B. All the three in parallel ◯

C. Two in series and one in parallel ◯

D. Two in parallel and one in series ◯

(3) Slope of I-V graph of a resistor is numerically equal to:

A. Conductivity ◯ B. Conductance ◯

C. Resistance ◯ D. Resistivity ◯

(4) Which one of the following is correct for an open circuit?

A. $V_t = 0$ ◯ B. $V_t < E$ ◯

C. $V_t = E$ ◯ D. $V_t = E - Ir$ ◯

(5) Magnetic flux will be maximum when:

A. Magnetic field is perpendicular to the plane area ◯

B. Magnetic field lies parallel to the plane area ◯

C. Area is held at an angle of 45° ◯

D. Magnetic flux density is perpendicular to area vector of the surface ◯

(6) A proton is moving along the axis of a solenoid carrying a current. The magnetic force on proton will be:

A. Radially inward ◯ B. Radially outward ◯

C. Zero ◯ D. Parallel to axis of solenoid ◯

FBISE SOLVED PAST PAPERS

(7) A steady current is passing through a coil, magnitude of self- induced emf in it, will be:

A. zero ◯ B. maximum ◯

C. $\varepsilon = L\frac{\Delta I}{\Delta t}$ ◯ D. $\varepsilon = -L\frac{\Delta I}{\Delta t}$ ◯

(8) At high frequency in a capacitive circuit, the current will be:

A. Large ◯ B. Small ◯

C. Zero ◯ D. Infinite ◯

(9) The peak value of A.C source is 20 A, its rms value will be:

A. 14.1 A ◯ B. 10 A ◯

C. 20 A ◯ D. 28.2 A ◯

(10) The materials in which disordered structure of liquid is frozen are:

A. Amorphous ◯ B. Crystalline ◯

C. Polycrystalline ◯ D. Quartz ◯

(11) The temperature below which the resistivity of a superconductor falls to zero is called:

A. Absolute temperature ◯ B. Kelvin temperature ◯

C. Limiting temperature ◯ D. Critical temperature ◯

(12) In a half wave rectifier, the diode conducts:

A. Only positive half of input cycle ◯

B. Only negative half of input cycle ◯

C. Both halves of input cycle ◯

D. Any one half of input cycle ◯

(13) The maximum kinetic energy of emitted photoelectrons, from different metal surfaces, depends upon:

A. Intensity of incident light only ◯

B. Frequency of the incident light only ◯

C. Nature of metal surface ◯

D. Both frequency of incident light and nature of metal surface ◯

(14) The rest mass of photon is:

A. Infinite ◯ B. Zero ◯

C. 1.6×10^{-27} kg ◯ D. 3×10^{8} kg ◯

(15) The type of spectra produced by atoms is:

A. Continuous spectra ◯ B. Band spectra ◯

C. Line spectra ◯ D. Braking radiation spectra ◯

(16) The shortest wavelength radiation series in Lyman Series have wavelength equal to:

A. $\frac{3}{4}R_H$ ◯ B. R_H ◯

C. $\frac{1}{R_H}$ ◯ D. $\frac{2}{R_H}$ ◯

(17) The half-life of a radioactive element which has only $\frac{1}{32}$ of its original mass left after elapsed of 60 days is:

A. 30 days ◯ B. 20 days ◯

C. 15 days ◯ D. 12 days ◯

FBISE SOLVED PAST PAPERS

PHYSICS MODEL QUESTION PAPER (3rd SET SOLUTION)
HSSC-II
SECTION A

1. A
2. C
3. B
4. C
5. A
6. C
7. A
8. A
9. A
10. A
11. D
12. D
13. D
14. B
15. C
16. C
17. D

SECTION B

Ans.2

i. FIELDS OF FORCE

Like to be gravitational field, the origin of electric force is still unknown, while the transmission of electric force is described by 'Michael Faraday' by using the concept of electric field.

Electric Field:

"The space or region around the charge in which it exerts electric force on other charges is called electric field".

Explanation:

It is intrinsic property of nature that an electric field exists in space around an electric charge. This electric field is considered to be a force field that exerts a force on a test charge placed in that region.

Thus, the field of charge q interacts with q_o to produce an electrical force. The attraction between q and q_o is accomplished in two steps:

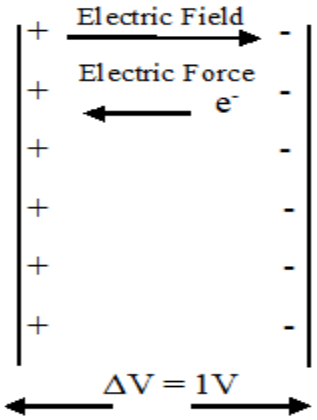
FBISE SOLVED PAST PAPERS

(i) Charge q produces a field

(ii) Field interacts with test charge q_o to produce a force on it.

Then the electric field can be represented by dots around the charge q, the density of the dots shows the strength of the field.

ii. Electron volt (eV): "One electron volt is the amount of energy acquired or lost by an electron when it is displaced across two points in the electric field between which potential difference is one volt."



By definition

$\Delta(KE) = 1$ eV, when $q = e = 1.602\times10^{-19}$ C and $\Delta V = 1$ V.

Thus $\Delta(KE) = W = q\,\Delta V$

$1eV = 1.602\times10^{-19}$ C×1 V

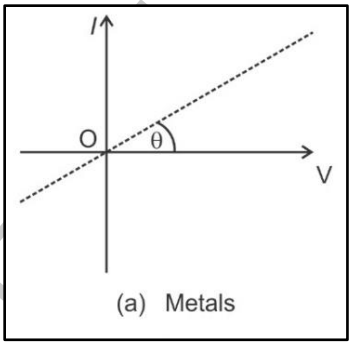
$= 1.602\times10^{-19}$ CV (CV = J)

$= 1.602\times10^{-19}$ J

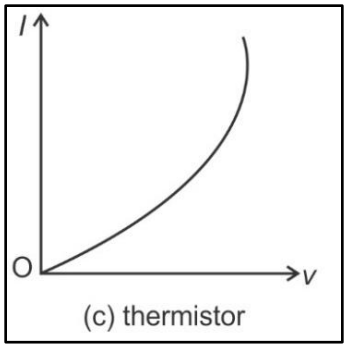
iii. Resistivity of thermistor: Resistivity of thermistors decreases with increase in temperature. Thermistors are made up of semiconductors. When its temperature rises, free electrons and hole pairs are created due to breaking of bonds. As number of charge carriers increase, so current in it increases and its resistance decreases.

Resistivity of copper wire: Resistivity of copper wire (metal) increases with increase in temperature. When temperature of copper wire (metal) increases, its free electrons collide more and more with atoms and decrease the current in it.

I-V characteristics are shown below.



(a) Metals



(c) thermistor

iv. Full forms of E.C.G. is Electrocardiogram.

The electrocardiogram or ECG is worldwide used for diagnosing heart conditions. An electrocardiogram is a recording of the small electric waves being generated during heart activity.

FBISE SOLVED PAST PAPERS

Full form of E.E.G. is Electroencephalography.

Electroencephalography, or EEG, is a neurological test that uses an electronic monitoring device to measure and record electrical activity in the brain.

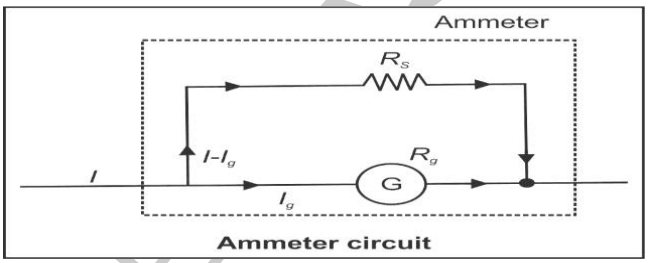
v. Sol.

$$r = 5\ cm = 5 \times 10^{-2} m$$
$$I = 5\ A$$
$$B = ?$$

For straight current current conductor, magnetic flux density (by Ampere's law)is:

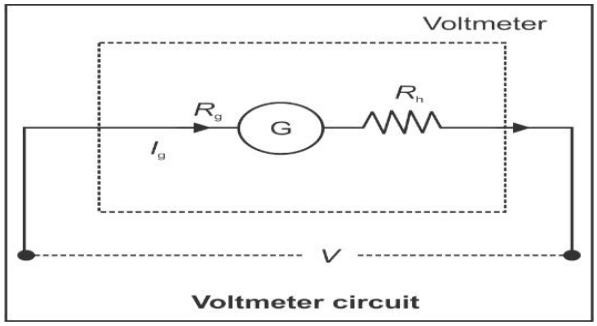
$$B = \frac{\mu_o}{2\pi}\frac{I}{r}$$
$$\Rightarrow B = \frac{4\pi \times 10^{-7}}{2\pi}\frac{5}{5 \times 10^{-2}}$$
$$\Rightarrow B = 2 \times 10^{-7+2} = 2 \times 10^{-5}\ Wb\ m^{-2}$$

vi. Conversion of Galvanometer into Ammeter: To convert galvanometer into ammeter,



we connect a very **small resistance** (shunt resistance) in **parallel** with it as shown.

Conversion of Galvanometer into voltmeter: To convert galvanometer into voltmeter, we connect a very **high resistance** in **series** with it as shown.



vii. Working of Induction Heater: Induction heater is basically made up of coil. When a metallic pot is placed on it. Induction heater produces heat in metallic pot by two ways.

FBISE SOLVED PAST PAPERS

i. Current flows through coil and it produces heat by combustion process.

ii. When alternating current passes through it, it produces changing magnetic field. This changing magnetic field induces eddy current in the metallic pot.

Due to production of extra heat, food in the pot cooks quickly.

viii. Sol.

$d = 2$ cm

$\Rightarrow r = \frac{d}{2} = \frac{2cm}{2} = 1\ cm = 1 \times 10^{-2} m$

$\Delta B = 10\ T$

$\Delta t = 0.1\ s = 10^{-1}\ s$

$\theta = 0^o$

$N = 1$ (for ring)

$\varepsilon = ?$

From Faraday's law of electromagnetic induction; magnitude of induced emf is:

$$\varepsilon = N \frac{\Delta \emptyset}{\Delta t}$$

$$\Rightarrow \varepsilon = N \frac{\Delta(BA \cos\theta)}{\Delta t} = N \frac{(\Delta B)\, A \cos\theta)}{\Delta t}$$

$$\Rightarrow \varepsilon = N \frac{(\Delta B)\, A \cos\theta}{\Delta t}$$

$$\Rightarrow \varepsilon = N \frac{(\Delta B)\, \pi r^2 \cos\theta}{\Delta t}$$

$$\Rightarrow \varepsilon = 1 \frac{(10)\,(3.14)(1 \times 10^{-2})^2 \cos 0}{(10^{-1})}$$

$$\Rightarrow \varepsilon = (3.14)((10)^{-4+1+1})\,(1) = 3.14 \times 10^{-2}\ V$$

ix. Basic Forces of Nature

There are four fundamental forces; (1) Gravitational force (2) Strong force (3) Electromagnetic force (4) Weak nuclear force

Electromagnetic Force:

- The electromagnetic force is about 10^{-2} times the strength of the strong force.
- It is a long-range force that decreases in strength as the inverse square of the separation
  - between interacting particles just like gravity.
- It causes all chemical reactions, binds all atoms, molecules, crystals, tree, building etc.
- Friction, cohesion and adhesion are due to this force.

Gravitational Force:

- Gravitational force is a long-range force that has a strength of only about 10^{-36} times that of strong force.
- It is the force that holds the planets, stars, and galaxies together

FBISE SOLVED PAST PAPERS

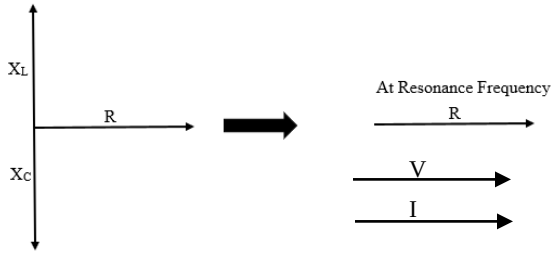
- It also follows inverse square law.
- Its effect on elementary particles is negligible. Thus, the gravitational force is the weakest of all the fundamental forces.

x. Resonance Frequency for RLC Series Circuit: It is the frequency of AC in RLC series circuit at which inductive reactance and capacitive reactance are equal.

At $f = f_r$ then $X_L = X_C$

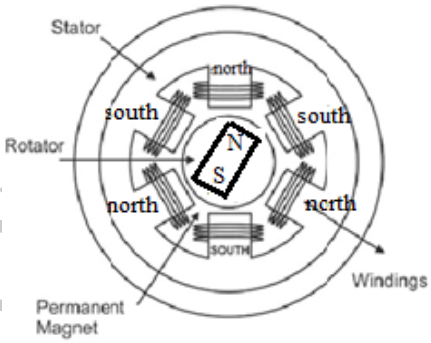
By solving, we get resonance frequency as:

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$



Power Dissipation at Resonance Frequency: At resonance frequency of AC in RLC series circuit, as $X_L = X_C$ and they are opposite, so they cancel each other. Circuit becomes only resistive. For resistive circuit, we know that voltage and current are in phase ($\theta = 0^o$).So, power factor "cos θ = cos 0° = 1 (maximum). Hence, power dissipation will be maximum for RLC series circuit at resonance frequency.

xi. **Stator** is the stationary part of the motor. **Rotor** is a coil or permanent magnet inside stator. The stator consists of a group of individual electromagnets i.e. coils arranged in



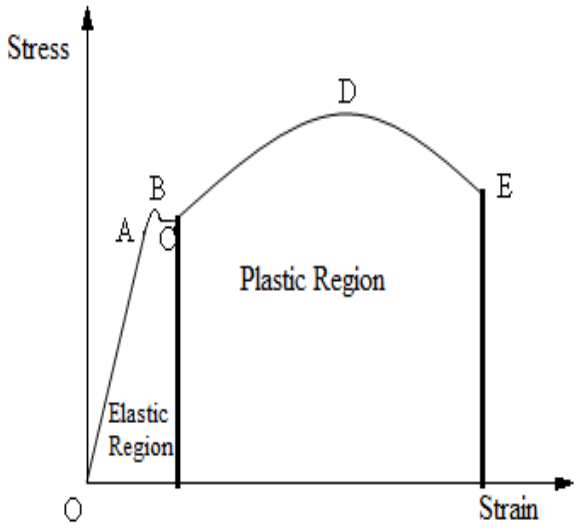
such a way that they form a hollow cylinder, with one pole of each magnet facing toward the center of the group. When alternating current passes through electromagnets of stator, it produces rotating magnetic field. Remember AC passing through its different coils have phase differences. That's why, when first end of the 1st coil has north pole then 2nd coil will have south pole at its first end. Rotor will be repelled by 1st coil and attracted by 2nd coil. At the very next moment, 2nd coil of stator will have north pole and 3rd coil will have south pole. So, now, rotor will be repelled by 2nd coil and attracted by 3rd coil and this process continues. It is how, stator's rotating magnetic field helps rotor to rotate continuously.

xii. Elasticity: If a material is deformed by applying stress and it returns to its original shape/ size after removing stress then its behaviour is called elasticity and the material is called elastic.

Plasticity

If a material is deformed by applying stress and it does not return to its original shape and size after removing stress (it is permanently deformed). Then its behaviour is called plasticity and the material is called plastic.

Stress Strain Curve for Ductile Material:



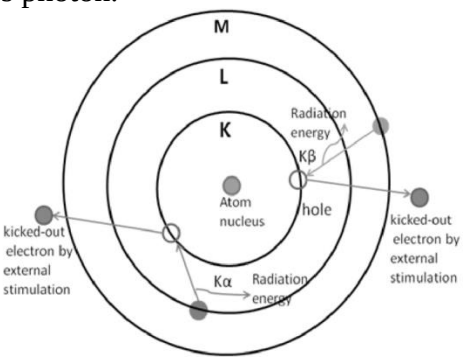
xiii. Characteristic X-rays:

When a heavy target material is bombarded with a beam of electrons, that has been accelerated by several keV. Some of these electrons will collide with inner-shell electrons of the target and knock them out of their respective atoms.

Let a K-shell electron is removed from an atom creating a vacancy for electrons in K-shell. Then an electron from either, L, M, or N-shell will quickly jump down to fill the vacancy in the K-shell emitting the excess energy as x-rays photon.

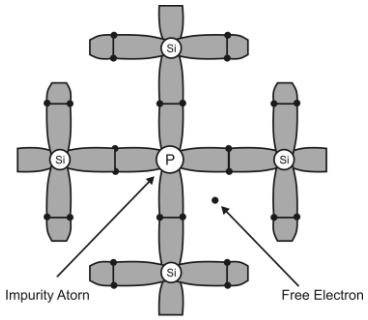
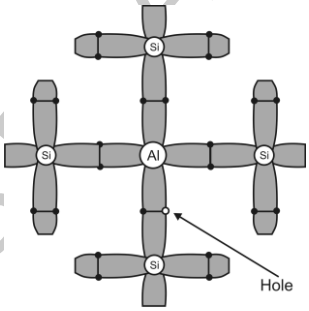
These x-rays consist of series of **specific wavelengths or frequencies and hence are called characteristic x-rays.**

An x-ray photon due to transition from L-shell to the vacancy in the K-shell is called K_α characteristic x-rays. The transition from M- and N-shell to the K-shell gives rise to K_β and K_γ characteristic x-rays respectively.



FBISE SOLVED PAPERS

xiv.

N-type Materials	P-type Materials
1. They are formed by doping of pentavalent impurity.	1. They are formed by doping of trivalent impurity.
2. Pentavalent impurity such as arsenic, antimony or bismuth belongs to 5th group.	2. Trivalent impurity such as boron, indium or gallium belongs to 3th group.
3. In these materials, majority charge carriers are free electrons.	3. In these materials, majority change carriers are holes.
4. In these materials minority charge carriers are holes. 	4. In these materials minority charge carriers are free electrons. 
5. Impurity atom is donor atom.	5. Impurity atom is acceptor atom.

xv. As base has very small width and it is lightly doped. Due to these characteristics, only few of free electrons recombine with holes when the charge carriers move from Emitter to Base region.

As Collector-Base junction is reversed biased by battery voltage V_{CC}, which is very much greater than Emitter-Base junction battery V_{BB} (i.e., $V_{CC} \rangle V_{BB}$). So the high voltage V_{CC} swept large number of charge caries from base to the collector region. Hence the collector current will increase and base current will decrease considerably.

As $\mathbf{I_E = I_B + I_C}$ It is clear from equation when I_c is very large, so I_B will be very small.

xvi. Uses of LASER

i. Surgical Tool

Laser beams are used as a surgical tool for welding detached retinas.

ii. Destroy Tissue

The narrow intense beam of laser can be used to destroy the tissue in a particular area. Tiny organelles with the living cell have been destroyed by using laser to study how the absence of that organelle affects the behavior of cell. This technique is also used to destroy cancerous cells.

FBISE SOLVED PAST PAPERS

iii. Seal off the Capillaries

The heat of the laser seals off capillaries and lymph vessels to prevent the spread of disease.

xvii. Beam of ***orange light*** contains greater number of photons

Reason

As energy of a photon is

$$E = hf = \frac{hc}{\lambda} \qquad (As\ \ v = f\lambda)$$

So energy of a photon is

$$E_n = n\frac{hc}{\lambda}$$

OR $$n = \frac{E_n\lambda}{hc}$$

As E_n , h and c are same

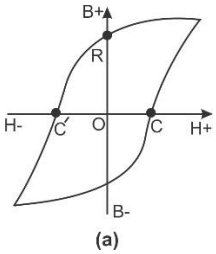
So $$n \propto \lambda$$

As $\lambda_{orange} > \lambda_{green}$

So, orange beam will have greater number of photons.

xviii.

- Materials which retain their magnetism and difficult to demagnetize are called Hard magnetic Materials. These materials are used for making permanent magnetic.
- Coercivity and retentivity values are large.
- Magnetic energy stored is high.
- They have large hysteresis loss due to large hysteresis loop area.



(a)

xix. When direct current passes through a choke coil, it only opposes the current due to resistance of its wire. But, when alternating current is passing through the choke coil, it not only opposes AC due to its resistance but also due to its reactance for AC. In case of coil, its resistance and reactance are taken in series. Therefore, impedance i.e. opposition to flow of current is greater for AC than DC.

xx. Wien's displacement law: At a given temperature T, the emitted energy has maximum value for a certain wavelength λmax and product λmax × T remains constant.

$$\lambda max \times T = \text{constant} \Rightarrow \lambda \max \alpha \frac{1}{T}$$

So, the increase in temperature causes the shift the shorter wave length.

This is called Wein's displacement law. The value of this constant is 2.9×10^{-3} mK.

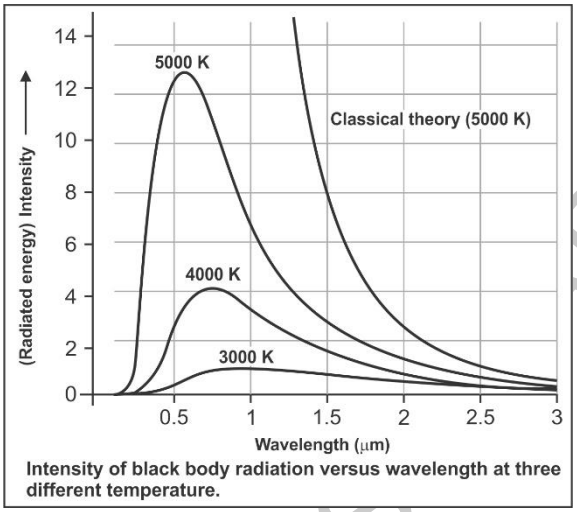
Stefan-Boltzmann Law: Boltzmann law states that the amount of energy of all wavelength radiate per second per unit surface area of a black body is directly proportional to the fourth power of its absolute temperature T.

FBISE SOLVED PAST PAPERS

$$E \propto T^4$$

$$E = \sigma T^4 \text{ ----- (3)}$$

Where σ is a constant called Boltzmann constant. Its value is 5.67×10^{-8} W.



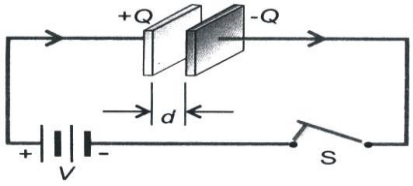
Intensity of black body radiation versus wavelength at three different temperature.

SECTION C

Ans 3a.

Energy Stored in a Capacitor:

Let us suppose that initially the capacitor is uncharged when voltage is zero. When it is connected to source of potential difference V, it is charged. Initially, when the capacitor is uncharged, the potential difference between the plates is zero ($V_i = 0$). Finally when charge +Q and (–Q) are deposited on the plates, the potential difference between the plates becomes V ($V_f = V$).



So, average potential difference V_{av} between plates of capacitor is:

$$V_{av} = \frac{0+V}{2} = \frac{1}{2}V$$

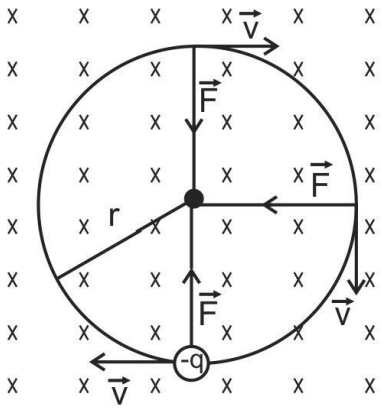
Thus the energy stored in a capacitor, is

$$\text{Electric P.E.} = W = Q\,V_{av}$$

$$= Q\left(\frac{1}{2}V\right)$$

$$\textbf{Electric P.E. } (U_E) = \frac{QV}{2} \qquad \text{…. (1)}$$

FBISE SOLVED PAST PAPERS



Where Q is the charge on a capacitor with a voltage V applied. Charge and voltage are related to the capacitance C of a capacitor by Q = CV and so the expression for U can be written in three equivalent expression as:

$$U_E = \frac{QV}{2}$$

$$= \frac{(CV)V}{2}$$

$$\mathbf{U_E = \frac{CV^2}{2}} \quad \text{.... (2)}$$

Put $V = \frac{Q}{C}$ in equation (1), we get:

$$\mathbf{U_E = \frac{Q^2}{2C}} \qquad \text{--- (3)}$$

Electric P.E. in the Form of Electric Field

We know that

$$V = E\,d$$

and

$$C = \frac{A\varepsilon_r\varepsilon_o}{d}$$

Substituting these values in Eq. (2), We get

$$U_E = \frac{1}{2} \times \frac{A\,\varepsilon_r\varepsilon_o}{d} \times (Ed)^2$$

$$U_E = \frac{1}{2}\,\varepsilon_r\varepsilon_o\,E^2 \times (Ad) \qquad \text{.... (4)}$$

Ans 3b. Determination of e/m for an electron:

When an electron is thrown perpendicular to the magnetic field, magnitude of magnetic force $F_{B(max)}$ experienced by charge acts as centripetal force. (i.e. $F_{Bmax} = qvB \sin 90^0 = q\,v\,B$)
So,

$$Fc = F_B$$

$$\frac{mv^2}{r} = evB$$

$$\frac{e}{m} = \frac{v}{Br}$$

Practically we shot beam of electrons into a magnetic field of known value, so B is known.

Calculation of radius of circular path:

Radius of the electrons can be measured by making their path visible by colliding them with a gas like hydrogen or helium in a tube place in uniform magnetic field. Electrons excite the atoms of the gas and their de-excitation causes emission of visible blue light. So, the path becomes visible.

FBISE SOLVED PAST PAPE

Measurement of Velocity

For the velocity of the electrons, their kinetic energy is measured by passing them through a potential difference of known value. Since:

$$\text{K.E.} = W$$

$$\frac{1}{2}mv^2 = Ve$$

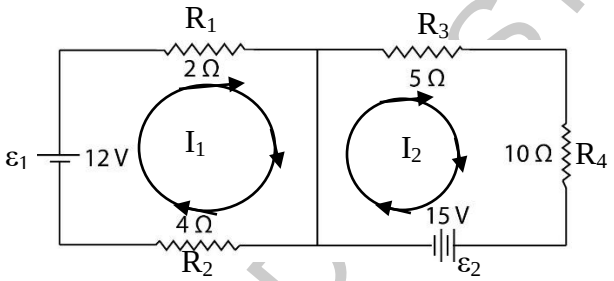
$$v^2 = \frac{2Ve}{m}$$

or

$$v = \sqrt{\frac{2Ve}{m}}$$

Ans 3c.

Sol.



Let I_1 and I_2 be currents in each loop and both currents are flowing in clockwise direction.

Apply KVL on first loop;

$$\varepsilon_1 - I_1R_1 - I_1R_2 = 0$$

$$\Rightarrow 12 - I_1(2) - I_1(4) = 0$$
$$\Rightarrow 12 = 2I_1 + 4I_1$$
$$\Rightarrow 6 = I_1 + 2I_1$$
$$\Rightarrow 6 = 3I_1$$
$$\Rightarrow \frac{6}{3} = I_1$$
$$\Rightarrow I_1 = 2A$$

Apply KVL on second loop;

$$-\varepsilon_2 - I_2R_3 - I_2R_4 = 0$$

$$\Rightarrow -15 - I_2(5) - I_1(10) = 0$$
$$\Rightarrow -15 = I_2(5) - I_1(10) = 0$$
$$\Rightarrow -3 = I_2 + 5I_2$$
$$\Rightarrow -3 = 6I_2$$
$$\Rightarrow \frac{-3}{6} = I_2$$

FBISE SOLVED PAST PAPERS

$$\Rightarrow I_2 = \frac{-1}{2}A$$
$$\Rightarrow I_2 = -0.5A$$

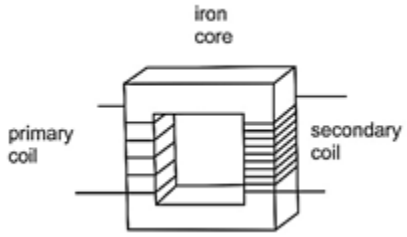
Negative sign shows that direction of current is opposite to our imagined direction of current i.e. direction of current in second loop is anti-clockwise (not clockwise).

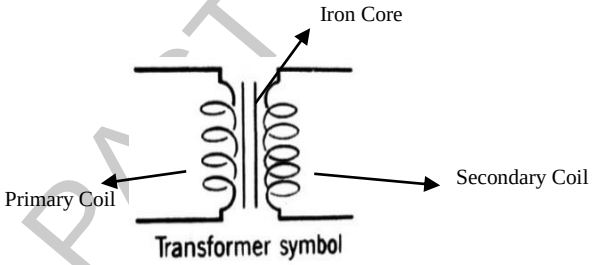
Ans 4a. Transformer:

Transformer is an electrical device which changes a given AC voltage into a larger or smaller AC voltage.

Principle:

It works on the principle of mutual induction between two coils wound on same iron core.





Construction

It consists of two coils of copper wire which are magnetically linked to each other (no electrical connection).

Primary coil: The coil to which A. C input power is supplied is called primary coil.

Secondary coil: The coil which delivers power to the output circuit is called secondary coil.

Coils are wound on the laminated iron core.

Working:

Current passing through the primary coil creates a magnetic field. The primary and secondary coils are wrapped around iron core, so that most of the magnetic flux passes through both the primary and secondary coils. So, the flux through the primary and secondary coil is same. The changing magnetic flux through the primary coil give rise to an induced e.m.f 'V_s' in the secondary coil according to faraday's law of e.m. induction.

Derivation:

Number of turns of the primary coil= N_p
Number of turns of the secondary coil= N_s
According to Faraday's law of electromagnetic induction the emf induced across the secondary coil is,

FBISE SOLVED PAST PAPERS

$$V_s = Ns \ \frac{\Delta\phi}{\Delta t} \quad \text{_____ (1)}$$

Since same magnetic flux passes through primary and secondary coil in an ideal transformer, therefore voltage across primary coil is given by:

$$V_p = N_p \ \frac{\Delta\phi}{\Delta t} \quad \text{_____ (2)}$$

Transformation Ratio

Dividing equation (2) by (1)

$$\frac{V_s}{V_p} = \frac{N_s \frac{\Delta\phi}{\Delta t}}{N_p \frac{\Delta\phi}{\Delta t}}$$

$$\boxed{\frac{V_s}{V_p} = \frac{N_s}{N_p}}$$

This equation is called transformation ratio.

Ans 4b.

Heisenberg Uncertainty Principle

It states that it is impossible to measure the position and momentum of a particle at same instant with unlimited precision.

Mathematically,

$$(\Delta x)(\Delta p) \approx h$$

Explanation:

Suppose we want to measure the position and momentum of an electron at a given instant. Let, light of wavelength 'λ' is used light to measure the position and momentum of electron.

Uncertainty in Position:

When a photon strikes an electron, it will change the position of electron within its own wavelength.

$$\text{i.e.,} \quad \Delta x \approx \lambda \qquad \ldots\ldots(1)$$

Where 'Δx' is the uncertainty in position of the electron and 'λ' is the wavelength of photon.

In order to reduce the uncertainty in position, we must use light of short wavelength.

Uncertainty in Momentum

In order to measure momentum of electron, when this photon strikes the electron, the maximum uncertainty of the measurement of momentum ΔP is given by

$$\Delta P \approx \frac{h}{\lambda} \qquad \ldots(2)$$

FBISE SOLVED PAST PAPERS

In order to reduce the uncertainty in momentum, we must use the light of longer wavelength.

Equation (1) shows that, in order to reduce to uncertainty in position (Δx), we must use light of shorter wavelength and eq. (2) shows that in order to reduce the uncertainty in momentum (ΔP), we must use light of longer wavelength. Thus, there are uncertainties.

Multiplying these two uncertainties, i.e., eq. (1) and eq. (2)

$$(\Delta x).(\Delta P) \approx \lambda\left(\frac{h}{\lambda}\right)$$

or $(\Delta x)(\Delta P) \approx h$

This is the mathematical form of uncertainty principle.

Ans 4c.

Given:

V_{rms} = 220 V

f = 50 Hz

R = 2.5 Ω

L = 6 mH = 6 x 10^{-3} H

C = 6.5μF = 6.5 x 10^{-6} F

To Find:

(i) X_L = ?

(ii) X_C = ?

(iii) Z = ?

(iv) I = ?

Solution:

(i) $X_L = 2\pi f L$

⇨ X_L = (2) (3.14) (50) (6 x 10^{-3}) = 1884 x 10^{-3} Ω

⇨ X_L = 1.884 Ω = 1.9 Ω

(ii) $Xc = \frac{1}{2\pi f C} = \frac{1}{(2)(3.14)(50)(6.5\times10^{-6})}$

⇨ $Xc = \frac{1}{2.041\times10^{-3}}$ Ω

⇨ X_L = 490 Ω

(iii) Since $X = X_c - X_L$ = 490 – 1.9 = 488.1 Ω

For RLC series circuit

$Z = \sqrt{R^2 + X^2}$

$Z = \sqrt{2.5^2 + 488.1^2} = \sqrt{6.25 + 238241}$ = 488 Ω

(iv) $I = I = \frac{V}{Z} = \frac{220}{488} = 0.45\ A$

FBISE SOLVED PAST PAPERS

Ans 5a.
Mass Spectrograph

It is a device with the help of which

i. We can separate isotopes of any element can be separated from one another
ii. Their masses can also be determined quite accurately.

Principle: A mass spectrograph is based upon the principle that a beam of ions moving through electric and magnetic fields suffers a deflection that depends upon the charge and masses of the ions.

Working: A simple mass spectrograph is shown in (fig). The atoms or molecules of the elements under investigation, in vapour form, are ionized in the ion source S. As a result of ionization, one electron is removed from the particles, leaving with a net positive charge +q on the positive ions, escaping the slit S_1 are accelerated through a potential difference V applied between two slits $S_1$and S_2.

The ion passes through slit S_2 in the form of a narrow beam. The K.E of single charged ion at the slit S_2 will be given by

$$\text{K.E.} = W$$

$$\text{K.E.} = Vq$$

$$\text{or} \quad \frac{1}{2}mv^2 = Vq$$

$$\text{or} \quad mv^2 = 2Vq$$

$$v^2 = \frac{2Vq}{m}$$

$$\mathbf{v} = \sqrt{\frac{2Vq}{m}} \qquad \textbf{… (1)}$$

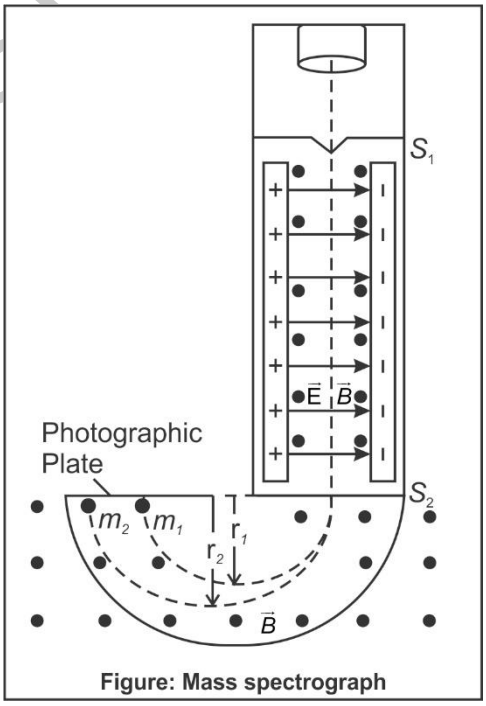


Figure: Mass spectrograph

The ions are then subjected to a perpendicular and uniform magnetic field B in a vacuum chamber, where they are deflected in semi-circular paths towards a detector due to action of magnetic force on them. The detector records the number of ions arriving per second. The centripetal force applied by magnetic fields is given by

Magnetic Force = Centripetal Force

$$F_m = F_C$$

$$qvB = \frac{mv^2}{r}$$

$$qB = \frac{mv}{r}$$

FBISE SOLVED PAST PAPERS

$$\mathbf{m = \frac{qBr}{v}} \qquad \text{.... (2)}$$

Putting the value of 'v' from equation (1) in (2) we get

$$m = \frac{qBr}{\sqrt{\frac{2Vq}{m}}}$$

Squaring both sides, we get

$$m^2 = \frac{q^2B^2r^2}{\frac{2Vq}{m}}$$

$$m^2 = \frac{q^2B^2r^2m}{2Vq}$$

$$\mathbf{m = \left(\frac{qr^2}{2V}\right)B^2} \qquad \text{... (3)}$$

We can therefore, compute the mass m of the ion if r, B, q and V are known.

We can also write (Eq.3) in the form $r^2 = \frac{2Vm}{qB^2}$

Taking square root of both sides

$$\mathbf{r = \sqrt{\frac{2Vm}{B^2q}}} \qquad \text{... (4)}$$

This relation shows that if V, B and q to be constant, r depends upon the mass m of the ion. Thus, ions of different masses will strike the photographic plate at different places, so, therefore, different isotopes can be separated from one another.

Ans 5b.

CT Scanner

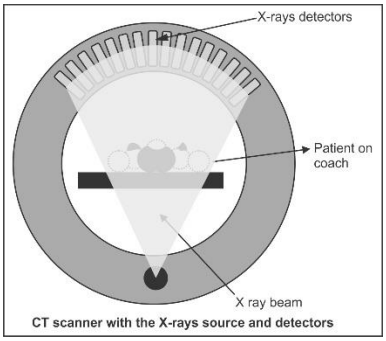
A 'normal' X-ray gives only limited information because it is rather like a shadow picture-fine detail within the image may be invisible especially if one organ lies in front of the region of the body being studies. To give a high-quality image, CT scans are used to identify internal structures of various part of the human body. CT Scans Machine is 3D machine with computer model.

In the CT scanner, there is one X-ray source but a large number of detectors.

- The source and the detectors are mounted in a large ring-shaped machine and the patient is placed inside this on a couch. Each detector records an image and the source and detectors are then rotated around the patient to give views from a variety of direction. The image is called a tomogram. The couch and patient are then moved along the axis of the machine and another set of images is taken.

FBISE SOLVED PAST PAPERS

- This large number of images (many hundreds) are then combined by a computer to give a composite detailed 3D image of the organs under investigation. The development of the CT scanner has been of enormous help in the study of the tumours in cancer patients where



CT scanner with the X-rays source and detectors

images of high quality are essential.

Ans 5c.

Sol.

Mass of proton = 1.007276 u

Mass of neutron = 1.008665 u

Mass of α particle = 4.002603 u

Number of protons = 2

Number of neutrons = 2

B.E. of α particle = ?

Calculation for the Binding Energy of α particle:

mass defect $\Delta m = Zm_p + Nm_n - m_\alpha$

$= 2m_p + 2m_n - m_\alpha$

$= 2 \times 1.007276u + 2 \times 1.008665u - 4.002603u$

$= 2.014552u + 2.01733u - 4.002603u$

$= 4.031882u - 4.002603u$

$\Delta m = 0.029279u$

Since $1u = 931$ MeV

B.E. $= 0.029279$ u $\times$ 931 MeV/u

B.E. $= 27.258749$ MeV $= 27.3$ MeV

FBISE SOLVED PAST PAPERS