(Section B)

Q. No. 2 Part (i)

Given:

$m = 800g = 0.8kg$ | $x = 12cm = 0.12m$

$F_{res} = 60N$

$x = 0.3m$

To Find $\omega = ?$

$a = ?$

Solution:

i) We know that

$F = -Kx$

$K = F/x = 60N/0.3m$

$K = 200$

$\omega = \sqrt{K/m}$

$= \sqrt{200/0.8} = 15.81$

acceleration $= a = -\omega^2 x$

$\omega = 15.81$

$x = 0.12m$

$a = -\omega^2 x$

$a = (15.81)(0.12)$

$= (250)(0.12)$

$a = 30\ ms^{-2}$

Q. No. 2 Part (ii) pressure with Density (ρ):—

we know that; $p = \frac{mN}{3V}\langle v^2 \rangle$ — (1)

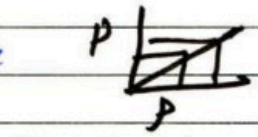
also $\frac{mN}{V}$ = density putting value in one

$p = \frac{1}{3}\frac{mN}{V}\langle v^2 \rangle$

$p = \frac{1}{3}\rho\langle v^2 \rangle$

p = pressure

ρ = density



pressure $\propto \rho$

Result:

it is proved that pressure exerted by the gas molecules on the system objects is directly proportional to the density of the gas.

(Section B)

Q. No. 2 Part (iii) **Uses of capacitors:**

Capacitors are primarily responsable for the storage of charges between its plates.

Uses:

i. increase the speed of fan.
ii. filters out the pulsating DC voltages.
iii. quickly stores and release energy useful in camera flashes.
iv. mobiles phone works accordingly on capacitors.
v. mostly used in refrigerators for efficient working.

Q. No. 2 Part (iv) **Mutual inductance: (M)**

The emf induced in the secondary coil due to the rate of change of current in the primary coil is called mutual inductance **OR** The ratio of the emf in the secondary coil to the rate of change of current in the primary coil

Unit: VSA^{-1}

Formula:

$$M = \frac{-\mathcal{E}_1}{\Delta I/\Delta t}$$

Factors:

i) Number of turns of coil
ii) change of current in primary coil.
iii) length of the conductor.

(Section B)

Q. No. 2 Part (v) Given:

$C = 0.5 \times 10^{-6}$ Farad

$\omega = 2 \times 10^{3}$

$V_0 = 16$

To Find: $X_c = ?$

Solution:

We know that

$$X_c = \frac{1}{\omega C}$$

$$= \frac{1}{(2 \times 10^{3})(0.5 \times 10^{-6})}$$

$$X_c = \frac{1}{1 \times 10^{-3}} = \boxed{1000 \text{ ohm}}$$

Q. No. 2 Part (vi) "Role of atmosphere in climate balance"

Atmosphere contains mixtures of gases that contribute to the maintanance of climate system.

- **Green house gases** absorb energy and makes the survival easy.
- incoming sunlight is absorbed by the atmosphere and rest is reflected toward space
- **precipitation** is a balance between the hot and cold climate systems and prevents droughts
- **EL Nino and LANINA** are wind streams that re-distributes the heat and energy over the whole surface of earth.
- Trade winds and subtropical gyres regulate wind penterns between the poles and equator.

(Section B)

Q. No. 2 Part (vii) **pair Annihilation:**

"The process where particle and its anti-particle comes close together and converts into two gamma ray photons." **Example:** electron and positron

Energy conservation:

$m_o c_e^2 + m_o c_p^2 = 2hf$ photon (at rest)

$K.E_e + K.E_p + 2m_o c^2 = 2hf$ (in motion)

momentum conservation:

$mv_e + mv_p = 2h/\lambda$ (photon)

charge conservation:

electron (−) + positron (+) = photons charge less (0)

1.05 Mev energy is required/released for annihilation rxn

Q. No. 2 Part (viii) **ultra Sound usage in Medical:**

These sound waves ranges in the ultra frequency range of radiations to which humans are unaudible.

Usage:

i) influence doctors to study defects in tissues, organs and body sensitive areas, diagnose the disease easily

ii) These waves are useful in the field of Neurology as it has not any damaging effect.

iii) usually these waves use during pregnancy for the detailed information of the foetal development.

iv) it is also used in the study of cancerous tumours and their detection.

(Section B)

Q. No. 2 Part (ix) Given:

$R = 20\ ohm$

$v = 220V$

$f = 20Hz$

calculate:

$V_0 = ?$

$I_0 = ?$

calculation:

We know that;

$V = \frac{V_0}{\sqrt{2}}$

$V_0 = V\sqrt{2}$

$V_0 = 220\sqrt{2}$

$V_0 = 311.126$

$I = \frac{I_0}{\sqrt{2}}$

$I = ?$

$V = IR$

$I = V/R$

$= 220/20$

$I = 11$

So that

$I_0 = I\sqrt{2}$ (rms)

$I_0 = 11\sqrt{2}$

$I_0 = 15.5$

Q. No. 2 Part (x) Wien's Displacement law:

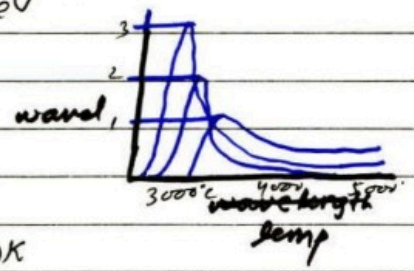
The wavelength of radiations emitted by the celestial body is inversely proportional to the absolute temperature

relation:

$\lambda \propto \frac{1}{Temp}$

$\lambda T = constant$

constant = $2.73 \times 10^{-3}\ mK$



The relation shows that by increasing temperature the wavelength of radiations decreases gradually and becomes mac energetic

(Section B)

Q. No. 2 Part (xi) Control rods:

The control rods are responsible for the maintaining of extent of reaction. it ensures that at a time one neutron is available for further fusion chain reaction. it is mainly made up of cadmium or boron.

Moderators:

Decrease the speed of neutrons because highly energetic ele neutrons can not undergo fision reaction as fision reaction need 0.03 Mev neutron for its occurence. it is usually water and graphite used in the process.

Q. No. 2 Part (xii) Average Translational K.E

Given:

temperature = $T = 47^{\circ}C = 320$ kelvin

$K = 1.38 \times 10^{-23} JK^{-1}$

To find: $\langle K.E \rangle = ?$

calculation:

We know that

$$\langle K.E \rangle = \frac{3KT}{2}$$

So,

$$\langle K.E \rangle = \frac{3(1.38 \times 10^{-23})(320)}{2}$$

$$\langle K.E \rangle = \frac{1.3248 \times 10^{-20}}{2}$$

$$\langle K.E \rangle = 6.624 \times 10^{-21} J$$

Hence the average T.K.E is find out.

(Section B)

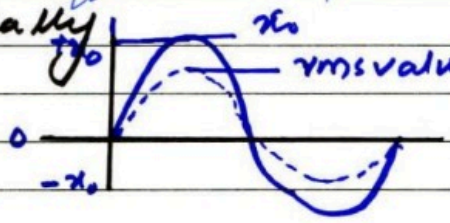
Q. No. 2 Part (xiii) **peak value (x_0):**

The Maximum value attained by the alternating voltage or current in a given cycle. The x_0 value may be positive ($+x_0$) or may be negative ($-x_0$) depending upon location of wave in cordinate system.

Root Mean Square or value: (rms)

it is that steady current value which when flowing through the resistor in circuit of AC produce the same effect as that produced by AC.

Graphically



$x_0 = (V_0, I_0)$ both can occur.

Q. No. 2 Part (xiv) **Fringe Spacing: (Y)**

The distance between two consecutive bright or dark fringes is called Fringe Spacing

Formula: $y = m\lambda/d$

Increasing of Y:

i) by increasing of wavelength of incident light

ii) increasing the order (m) for both light and dark fringes.

(iii) decreasing the distance between slits

Mathematicaly:

$d \sin\theta = m\lambda$

$\therefore \tan\theta = Y/L$ (for small angle θ)

d since

$d\, Y/L = m\lambda$

$Y = m\lambda L$

$m = 0, 1, 2, 3$ (c)

$m = m + 1/2$ (d)

Note: Fringe Spacing d same for both the constructive and distructive interference.

(Section C)

Q. No. 3 (Page 1)

GRVITATIONAL POTENTIAL ENERGY and POTENTIAL

Definition: The amount of energy required to move a point from a reference to infinity under the influence of gravity.

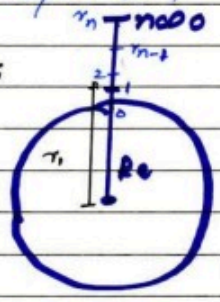
potential Energy:

P.E = mgh (is not applicable for long distances above the earth surface.

Derivation:

consider a mass (m_o) is placed on the earth surface work done on it is equal to p.E:

$W = p.E$



Now work done from $0 \rightarrow 1$:

$W = F_{av} \cdot \Delta d \cos\theta$

$W = F_{av} \cdot \Delta d \cos 180^\circ$

$W = -F_{av} \Delta d$

$\Delta d = (r_1 - Re)$

$F_{av} = -\frac{G m_o M_e}{r_{av}^2}$ —(i)

Now For r_{av} :

$r_{av} = \frac{Re + r_1}{2}$ ∴ $Re\ r_1 = Re + Dr$

$r_{av} = \frac{Re + Re + Dr}{2}$

$= \frac{2Re + Dr}{2}$

(Section C)

Q. No. 3 (Page 2) $r_{av} = \frac{R_e + D_r}{2}$

Squaring:

$r_{av}^2 = \left(\frac{R_e + D_r}{2}\right)^2$

$(a+b)^2 = (a^2 + 2ab + b^2)$

$r_{av}^2 =$

$(R_e)^2 + 2(R_e)\left(\frac{D_r}{2}\right) + \left(\frac{D_r}{2}\right)^2$

$\therefore \left(\frac{D_r}{2}\right)^2 = 0$

$R_e^2 + R_e D_r$

$R_e^2 + R_e(r_1 - R_e)$

$R_e^2 + R_e r_1 - R_e^2$

$\boxed{r_{av}^2 = R_e r_1}$

put in eq (i)

$F = -\frac{G m_o m_e (r_1 - R_e)}{R_e r_1}$

$W_{0\to1} = -\frac{G m_o m_e}{R_e r_1}(r_1 - R_e)$

$W_{0\to1} = -G m_o m_e \left(\frac{r_1 - R_e}{R_e r_1}\right)$

$W_{0\to1} = -G m_e m_o \left(\frac{1}{R_e} - \frac{1}{r_1}\right)$

Similarly

work $1 \to 2$

$W_{1\to2} = -G m_e m_o \left(\frac{1}{r_1} - \frac{1}{r_2}\right)$

Work $n-2 \to n-1$

$W = -G m_e m_o \left(\frac{1}{r_{n-2}} - \frac{1}{r_{n-1}}\right)$

Work $n-1 \to n$

$W = -G m_e m_o \left(\frac{1}{r_{n-1}} - \frac{1}{r_n}\right)$

$W_{net} = (W_1 + W_2 + W_3 \cdots + W_{n-2} + W_{n-1} + W_n)$

$W = -G m_e m_o \left(\frac{1}{R_e} - \frac{1}{r_1}\right) + -G m_e m_o \left(\frac{1}{r_1} - \frac{1}{r_2}\right) + -G m_o m_e \left(\frac{1}{r_{n-2}} - \frac{1}{r_{n-1}}\right) + -G m_o m_e \left(\frac{1}{r_{n-1}} - \frac{1}{r_n}\right)$

$W = -G m_o m_e \left(\frac{1}{R_e} - \frac{1}{r_1} + \frac{1}{r_1} - \frac{1}{r_2} \cdots \frac{1}{r_{n-2}} - \frac{1}{r_{n-1}} + \frac{1}{r_{n-1}} - \frac{1}{r_n}\right)$

$W = -G m_o m_e \left(\frac{1}{R_e} - \frac{1}{r_n}\right)$

(Section C)

Q. No. 3 (Page 3) $r_n = \infty = 0$

$$W_{net} = -GM_oM_e\left(\frac{1}{R_e} - \frac{1}{r_n}\right)$$

$$W = -GM_oM_e\left(\frac{1}{R_e} - \frac{1}{\infty}\right)$$

$$W = \frac{-GM_oM_e}{R_e} \Rightarrow \text{Specifically for earth}$$

$$W = -\frac{GM_oM_e}{R_e} \Rightarrow \text{for other planets.}$$

Basically work is stored in the form of gravitational potential energy (U).

$$U = -\frac{GM_oM_e}{r}$$

Gravitational Potential:

"The work done per unit mass inside the gravitational field"

$$V = \frac{W}{m} = \frac{U}{m}$$

$$V = -\frac{GM_oM_e}{r} \times \frac{1}{m_o}$$

$$V = \frac{-GM_e}{r}$$

Hence we have proved the potential for the object in gravitational field.

(Section C)

Q. No. 4 (Page 1)

ENERGY stored in Capacitor

The amount of energy (E) stored in capacitor is directly related with the product of charge (Q) and the voltage across the ends of the plates.

$$E = U = \frac{1}{2} QV$$

$$= \frac{1}{2} CV^2$$

Explanation:

⇒ initially when the capacitor plates are uncharged the value of charge on the plates is zero

⇒ when a voltage source is connected to the capacitor, charges gradually accumulates on the plates of the capacitors

⇒ prior, the current is high but with the storage of charge current decreases.

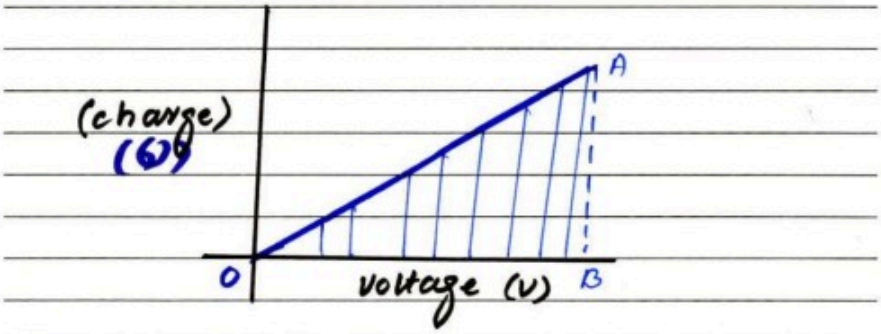
⇒ when the voltage (V) get maximum value ($V = V_0$) then maximum ~~current~~ charge ($Q = Q_0$) is stored on the plates of capacitor.

⇒ charge is stored on plates due to the phenomenon of (electrostatic induction)

We assume that the greater charge is stored on the capacitor if voltage is V_0.

(Section C)

Q. No. 4 (Page 2) **GRAPH:**



Derivation:

From Δ AOB.

The area of the triangle gives the stored energy relation.

Area of triangle = $\frac{1}{2}$ (Base)(Height)

$E = \frac{1}{2} VQ$

$E = \frac{1}{2} QV$

$\therefore Q = CV$

$E = \frac{1}{2} (CV)(V)$

$E = \frac{1}{2} CV^2$

$\therefore V = Q/C$

if we put $V = Q/C$ then

$E = \frac{1}{2} CV^2$

$E = \frac{1}{2} C\left(\frac{Q}{C}\right)^2$

$E = \frac{1}{2} \frac{Q^2}{C^2}$

$E = \frac{1}{2} \frac{Q^2}{C}$

$E = Q^2/2C$

(Section C)

Q. No. 4 (Page 3)

(B)

Given:

charge = Q = 5C

V = potential difference = 15V

To find = E = ?

Calculation:

$E = \frac{1}{2} QV$

putting values

$E = \frac{1}{2}(5C)(15)$

$E = \frac{75}{2}$

$E = 37.5$ Joules

(Section C)

Q. No. 5 (Page 1)

PHOTO Electric effect:

The phenomenon where the current is produced when photons collides with metal having free electrons.

PHOTO — light
Electric — Electricity

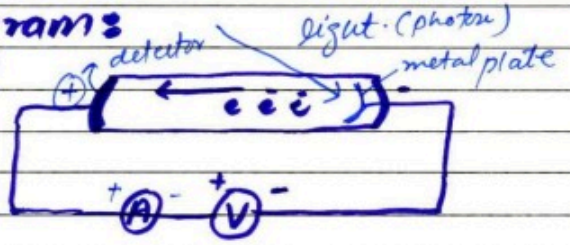
Explanations:

⇒ consider an evacuated tube having a metal plate and the detector connected to a power supply of voltage (V)

⇒ The metal plate is connected to cathode while the detector is connected to the anode of the battery.

⇒ An ammeter is connected in series to the voltage source.

Diagram:



Working:

⊙ During Dark Ammeter shows zero deflection.

⊙ During light Ammeter shows deflection

(Section C)

Q. No. 5 (Page 2)

Work function: (ϕ)

The (min) amount of work done (energy) required to eject an electron from the surface of metal.

$\phi = (hf - K.E_{electron})$ Unit: joule.

↓ energy of photon $\phi = hf'$

photo Electric Equation:

$$hf = hf' + K.E$$

Explanation:

When a photon with energy ($E = hf$) colides with electron at rest some of its energy transfers to electron and the rest of energy is utilised on ejecting the electron as work function.

Threshold frequency:

The min frequency of photon required to remove electron from a metal.

Conditions

- if $E < \phi$ then no photo electric effect occurs
- if $E = \phi$ then the K.E electron is zero and more.
- if $E > \phi$ then the K.E of electron have

(Section C)

Q. No. 5 (Page 3)

Effect of Frequency on K.E of electrons

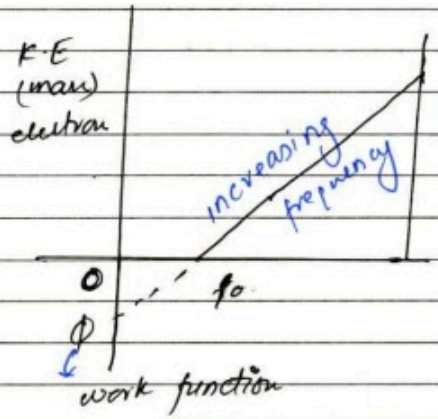
The kinetic energy of the electrons is greatly influenced by the frequency of the incident radiations not of the intensity. greater the photon energy greater will be its conversion into the kinetic energy of electron.

$E = hf$ K.E$_{(e)}$ $\propto$ frequency$_{(P)}$

$E = eV$

$\boxed{eV = hf}$ ⇒ formula relating kinetic energy of electron with photon energy.

Graphically:



Note:

From the graph it is shown that K.E of electron is directly related with the energy or frequency of photon.

(Section C)

Q. No. 6 (Page 1)

Relation Derivation for Nucleus Decay exponential with time.

We know that; Decay constant is given as:

$$\frac{\Delta N}{\Delta t} = -\lambda N$$

for small change we take the derivative (d)

$$\frac{dN}{dt} = -\lambda N$$

Re-arranging the equation

$$\frac{dN}{dN} = -\lambda dt$$

taking integration:

$$\int \frac{dN}{dN} = -\int \lambda dt$$

$$\ln N = -\lambda t + \text{constant} \quad -(a)$$

For constant value put $N = N_0$ and $t = 0$

$$\ln N_0 = -\lambda(0) + \text{constant}$$

$$\ln N_0 = \text{constant} \quad -(b)$$

(Section C)

Q. No. 6 (Page 2) put the eq (B) in eq (A)

$$\ln N = -\lambda t + \ln N_0$$

$$\ln N - \ln N_0 = -\lambda t$$

$$\ln\left(\frac{N}{N_0}\right) = -\lambda t$$

taking exponent on both sides

$$\frac{N}{N_0} = e^{-\lambda t}$$

$$N = N_0 e^{-\lambda t}$$

Hence it is proved that the (N) decay of the nucleus is exponential with time

Where;

N = decay Sample
N_0 = original
λ = decay constant
t = the time it take for decay.

(Section C)

Q. No. 6 (Page 3)

—Q(B)—

Given:

$T_{1/2}$ = 9.70 hours = 9.70 × 3600 sec = 34920

To Find: λ = ?

Calculation:

From the relation b/w half life and decay constant

$$\lambda = \frac{0.893}{T_{1/2}} \rightarrow \text{Formula}$$

$$= \frac{0.693}{34920} \rightarrow \text{putting values.}$$

$$\lambda = 1.984 \times 10^{-5}$$