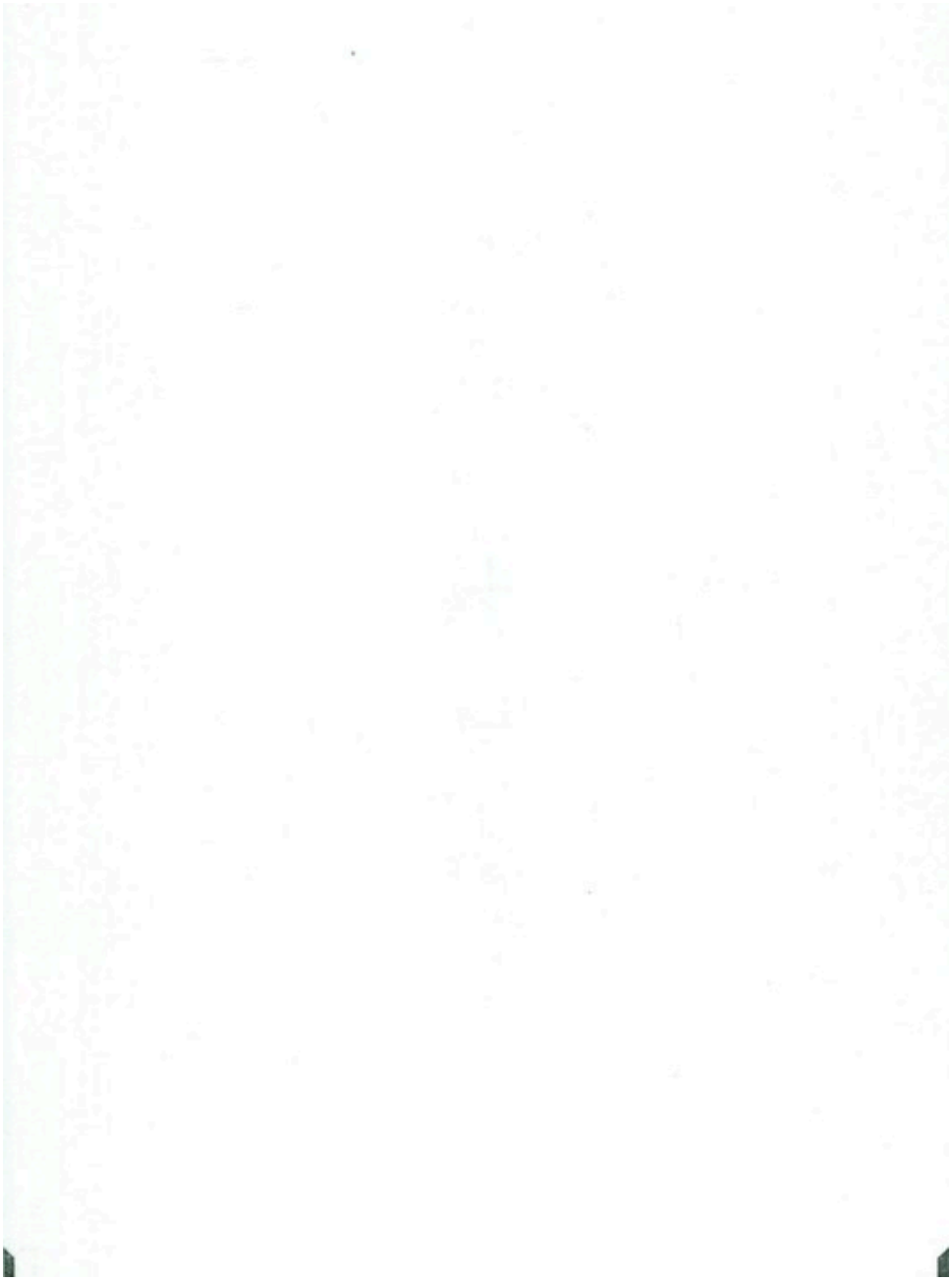
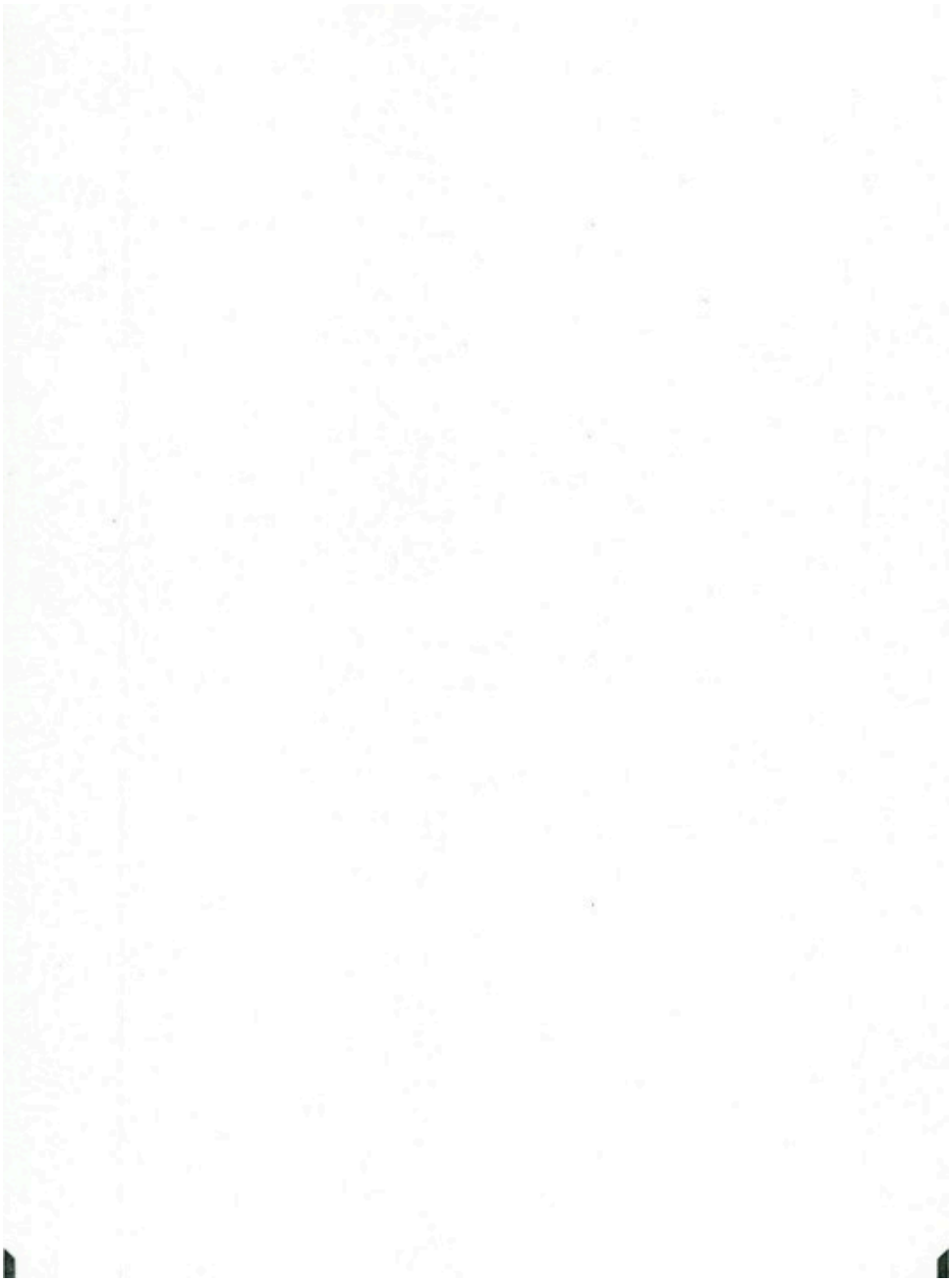
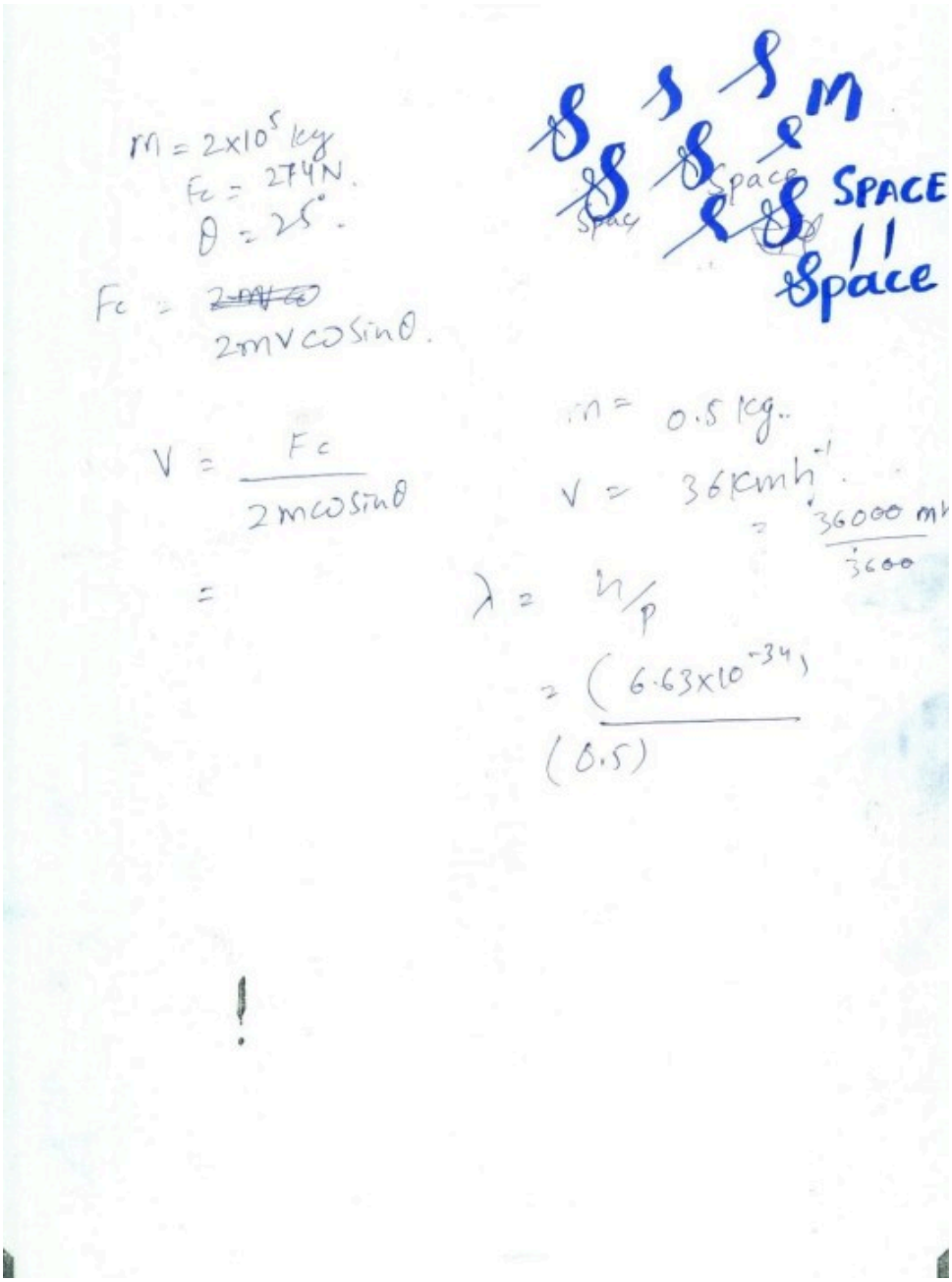





m = 2x10^5 kg
Fc = 274N.
θ = 25°.
Fc = 2mvcosinθ.
V = Fc / 2mcosinθ
=
SPACE
11
Space
m = 0.5 kg.
V = 36kmh^-1
= 36000 m
3600
λ = h/p
= (6.63x10^-34)
(0.5)

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Q. No. 2 Part (i) **GIVEN:**

$m = 800g$
$= 0.8kg.$
$F_x = 60N.$
(When $x = 0.3m$).
a. $\omega = ?$
b. a when $x = 0.12m.$

SOLUTION:

$K = F_x/x$
$= 60N/0.3m$
$= 200Nm^{-1}.$
a. $\omega = \sqrt{K/m}$
$= \sqrt{\frac{200}{0.8}}$
a. $\omega = 15.8 rad/s.$
b. $a = -x\omega^2.$
$= (0.12)(15.8)^2$
$a = 29.95 ms^{-2}$

RESULT:

$\omega = 15.8 rad/s.$
$a = 29.95 ms^{-2}.$

Q. No. 2 Part (ii) **CONDITIONS FOR INTERFERENCE FRINGES:** The conditions necessary for observing interference fringes are given below:

i. Coherent sources: The two sources emitting the waves which undergo interference must be coherent which means that they should emit waves with a **definite phase relationship** and they should have similar wavelength and frequency.

ii - Narrow slits: The slits should be narrow and the separation between them should be comparable to the wavelengths of the waves used.

iii. Stable environment and setup: The setup must be stable and should be free from disturbances such as vibrations and air which could disrupt the interference pattern.

(Section B)

Q. No. 2 Part (iii) **THREE USES OF CAPACITORS:**

(In household appliances): The three uses are given below:

i. **Capacitor in fan:** Capacitors are used to increase the speed of fans.

ii. **Use in refrigerators:** Capacitors are used in refrigerators to keep the compressor running.

iii. **Use in radio and TV:** Capacitor is used to filter unwanted frequencies in radio and TV sets.

.....

Q. No. 2 Part (iv) **GIVEN:**

'g' = ? $R_E = 6.4 \times 10^6$ m.

h = 35700 km

or $h = 35700 \times 10^3$ m.

SOLUTION:

$$g_h = \frac{GME}{(R_E + h)^2}$$

Putting the values:

$$g_h = \frac{(6.67 \times 10^{-11})(6 \times 10^{24})}{[6.4 \times 10^6 + 35700 \times 10^3]^2}$$

$$g_h = \frac{(6.67 \times 10^{-11})(6 \times 10^{24})}{1.77 \times 10^{15}}$$

$$\boxed{g_h = 0.225\ ms^{-2}}$$

RESULT: The value of gravitational field strength will be $0.225\ ms^{-2}$.

(Section B)

Q. No. 2 Part (v)

GIVEN:

X_c (capacitative reactance) = ?

$C = 0.5\,MF$

$C = 0.5 \times 10^{-6}\,F$.

Given relation:

$V = 16\sin(2\times10^3 t)\,V$.

SOLUTION:

The given relation is:

$V = 16\sin(2\times10^3 t)\,V$.

As, $V = V_0\sin(\omega t)$

So,

We can see that according to the given relation:

$\omega = 2\times10^3\ rad/s$.

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

$$= \frac{1}{(2\times10^3)(0.5\times10^{-6})}$$

$$= \frac{1}{1\times10^{-3}}$$

$X_c = 1000\,\Omega$.

Capacitative reactance $= 1000\,\Omega$.

Q. No. 2 Part (vi)

CONTRAST IN X-RAY IMAGING:

'Contrast' in X-ray imaging is **the brightness** which ranges from dark to light.

Purpose / Use of contrast: Contrast is used in X-ray imaging because X-rays are sufficient when looking at bones and other dense structures which absorb X-rays but there is difficulty when looking at X-rays of **soft tissues**. Hence contrast is used when looking at X-ray images of soft tissues. Contrast (brightness) makes the soft tissues more apparent and allows to evaluate them with ease.

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Q. No. 2 Part (vii) **PAIR ANNIHILATION:** Pair annihilation is the process in which a **particle and an antiparticle (e.g electron-positron)** pair collide and their energy is changed to photons.

Conservation of Energy: Energy is conserved during pair annihilation. The total energy before and after collision must be the same. E.g in electron-positron annihilation: $m_0c^2 + m_0c^2 = 2hf$
(Energy of e^- & positron) (Energy of photons)

In case e^- & e^+ are moving: $K.E_{e^-} + k.E_{e^+} + 2m_0c^2 = 2hf$.

Conservation of momentum: Momentum is also conserved during this process. The **photons move in opposite directions** to conserve momentum. The total momentum before and after collision remains same.

Q. No. 2 Part (viii) **APPLICATIONS OF ULTRASOUND:**
Two applications of ultrasound in medical technology are given below:

i- Use in medical imaging: Ultrasounds are used to generate images of internal body structures in a process called **echography or sonography**. The great advantage of using ultrasounds over other imaging techniques is that ultrasounds are comparatively **less harmful** and can even be used for unborn babies.

ii- Neurosurgery and disease treatment: The ability to concentrate ultrasounds in a specific region without damaging surrounding tissues makes them useful in neurosurgery. Ultrasounds are also used in the treatment of arthritis, muscular rhematism and sciatta etc.

(Section B)

Q. No. 2 Part (ix) **GIVEN:**

$R = 20\ \Omega$.

$V_{rms} = 220\ V$.

$f = 50\ Hz$.

a. $V_o = ?$ b. $I_o = ?$

SOLUTION:

a. $V_{rms} = V_o/\sqrt{2}$

So, $V_o = V_{rms} \times \sqrt{2}$

$= 220 \times \sqrt{2}$

$\boxed{V_o = 311\ V}$

b. $I_o = ?$

By OHM's law:

$V_o = I_o R$

$I_o = V_o/R$

$= 311/20$

$\boxed{I_o = 15.55\ A}$

RESULT:

$V_o = 311\ V$.

$I_o = 15.55\ A$.

Q. No. 2 Part (x) **WIEN'S DISPLACEMENT LAW AND TEMPERATURE (of a star):** Wein's displacement law states that: "The black body radiation curve for different temperatures peaks at a wavelength which is inversely proportional to the temperature of the body". Hence, $\lambda_{max} \propto 1/T$

$\lambda_{max} = \text{Constant}/T$ $\quad T\lambda_{max} = 2.9 \times 10^{-3}\ mK$.

The equation given above is the **formula for wein's displacement law.** (constant)

Temp. of a star can be determined using this law if we consider the star to be a **black body** and if we determine the wavelength emitted by the star at the peak intensity (λ_{max}), we can easily determine the star's temperature:

Temp. of the star $= \dfrac{2.9 \times 10^{-3}\ mK}{\lambda_{max}}$

(Section B)

Q. No. 2 Part (xi) **CONTROL RODS:** Control rods are used to **control the extent of the reaction** and they make sure that all of the material does not react at once. control rods are made of a material such as **boron or cadimium** which absorbs neutrons. The control rods absorb neutrons and allow one neutron in each fission event to cause further fission. Control rods can move in or out of the core as per need.

MODERATORS: The moderator **slows down the neutrons** as in fission fast moving neutrons are produced but slow moving neutrons are required for fission. Moderators increase the chance of fission to occur. Moderator is usually **water or graphite.**

Q. No. 2 Part (xii) **GIVEN:**

Temp. = 47°C.

Temp. in kelvin = 47°C + 273 = 320K.

$\langle K.E \rangle = ?$

SOLUTION:

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

$= \frac{3}{2} (1.38 \times 10^{-23})(320)$

$= \frac{3}{2} (4.416 \times 10^{-21})$

$= 6.624 \times 10^{-21} J.$

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

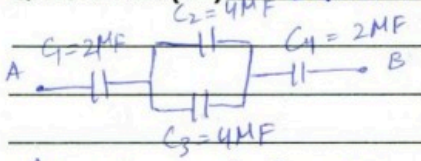
RESULT: The average transitional K.E of the gas molecules at 47°C will be $6.624 \times 10^{-21} J$

(Section B)

Q. No. 2 Part (xiii)

PEAK VALUE	RMS VALUE
i- The maximum value of the alternating voltage is called the peak value.	i- RMS value of alternating voltage is that steady voltage (DC) which when applied through a resistor generates the same amount of heat as the heat produced by the AC voltage through a resistor.
ii- It is always greater.	ii- It is always smaller.
iii- It is not the effective value of voltage.	iii- It is the effective value of voltage.
iv- It is given as, $V_0 = \sqrt{2} \times V_{rms}$.	iv. It is given as, $V_{rms} = \frac{V_0}{\sqrt{2}}$

Q. No. 2 Part (xiv) Solution,



As C_2 and C_3 are connected in parallel:

$C_{eq_{2,3}} = C_2 + C_3$

$= 4MF + 4MF$

$C_{eq_{2,3}} = 8MF$

Now, C_{eq} between A & B can be can be given as:

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_{eq_{2,3}}} + \frac{1}{C_3}$

(As they are in series):

$\frac{1}{C_{eq}} = \frac{1}{2MF} + \frac{1}{8MF} + \frac{1}{2MF}$

$\frac{1}{C_{eq}} = \frac{9}{8} MF$

$C_{eq} = \frac{8}{9} MF$

or $C_{eq} = 0.889 MF$

or $C_{eq} = 0.88 \times 10^{-6} F$

(Section C)

Q. No. 3 (Page 1)

BRIEF DESCRIPTION OF GRAVITATIONAL POTENTIAL:

"Gravitational potential" at a point is the amount of **work done on a unit mass** in moving it from infinity to that point. It is represented by V or φ. Gravitational potential is the Gravitational potential energy per unit mass and can be given as:

$$V(\varphi) = U/m$$

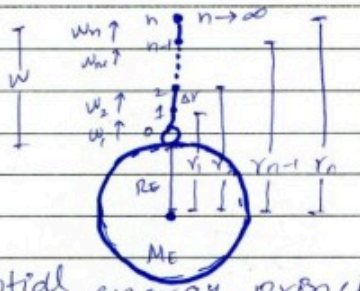
$$= \frac{-GMEm}{r}$$

$$\varphi = -GME/r$$

DERIVATION: To derive the expression for gravitational potential, we need to find the gravitational potential energy and divide it by unit mass. Consider a point on a surface of the earth where a body of mass 'm' is situated. This body is displaced from the point O to 'm'. As the gravitational force does not remain constant but varies inversely with the square of distance so we divide the distance into small distances so that gravitational force remains constant:

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Q. No. 3 (Page 2)



By work Potential energy principle:

$$\Delta P.E = W_{net}.$$

Total work done by a variable force is the sum of individual work:

$$W_{net} = W_1 + W_2 + W_3 + \dots + W_n.$$

$$W_1 = F_{av} \cdot \Delta r$$

$$= F_{av} \Delta r \cos\theta.$$

$\theta = 180^\circ$ so, $\cos\theta = -1$.

$$W_1 = -F_{av}\Delta r$$

F_{av} can be given as:

$$F_{av} = \frac{GM_E m}{r_{av}^2}$$

r_{av} is neither R_E nor r_1. We can find r_{av} as:

$$r_{av} = \frac{R_E + r_1}{2} \quad (\because \Delta r = r_1 - R_E, \; r_1 = R_E + \Delta r).$$

$$= \frac{R_E + R_E + \Delta r}{2}$$

$$= \frac{2R_E + \Delta r}{2} = R_E + \Delta r/2$$

Taking square:

$$r_{av}^2 = R_E^2 + \frac{\Delta r^2}{4} + 2R_E\frac{\Delta r}{2}$$

As Δr is very small so $\Delta r^2/4$ approaches to

(Section C)

Q. No. 3 (Page 3) ZERO :

$r_{av}^2 = R_E^2 + R_E \Delta r$

$= R_E^2 + R_E (r_1 - R_E)$

$= R_E^2 + R_E r_1 - R_E^2$

$r_{av}^2 = R_E r_1$

$F_{av} = \frac{G M_E m}{R_E r_1}$

$W_1 = -\frac{G M_E m}{R_E r_1} \Delta r = \frac{G M_E m}{R_E r_1} (r_1 - R_E)$

$= -G M_E m \left(\frac{r_1}{R_E r_1} - \frac{R_E}{R_E r_1} \right)$

$W_1 = -G M_E m \left(\frac{1}{R_E} - \frac{1}{r_1} \right)$

Similarly, $W_2 = -G M_E m \left(\frac{1}{R_E r_1} - \frac{1}{r_2} \right)$

$W_3 = -G M_E m \left(\frac{1}{r_2} - \frac{1}{r_3} \right)$

$W_n = -G M_E m \left(\frac{1}{r_{n-1}} - \frac{1}{r_n} \right)$

$W_{net} = W_1 + W_2 + W_3 + \cdots + W_n$

$= -G M_E m \left(\frac{1}{R_E} - \frac{1}{r_1} + \frac{1}{r_1} - \frac{1}{r_2} + \frac{1}{r_2} - \frac{1}{r_3} + \cdots + \frac{1}{r_{n-1}} - \frac{1}{r_n} \right)$

$W_{net} = -G M_E m \left(\frac{1}{R_E} - \frac{1}{r_n} \right)$

If n is at infinity then $\frac{1}{\infty} = 0$ so,

General reaction for gravitational potential energy :

$G.P.E = U = -\frac{G M_E m}{r}$

As Gravitational potential is U/m so,

Gravitational potential $\Psi = \frac{-G M_E m}{r/m} = \frac{-G M_E}{r}$ or $-GM/r$

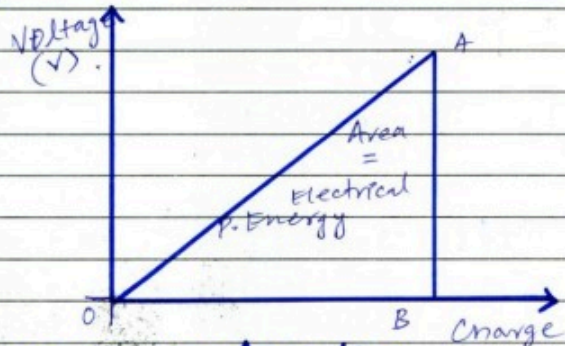
(Section C)

Q. No. 4 (Page 1)

ELECTRICAL POTENTIAL ENERGY IN A CAPACITOR: The energy stored by a capacitor is in the form of electrical potential energy. here it is related to the **charge and** potential difference. The first charge placed on the capacitor experiences a potential difference of 0V and the final charge experiences a change in potential difference of ΔV.

a ELECTRICAL P.E FROM A GRAPH:

The charge of the plates of a capacitor is **directly proportional** to the voltage across its plates so the graph of charge and voltage of a capacitor is a straight slope;



The **area under the q-v graph is equal to the electrical potential energy stored in the** ~~grap~~ capacitor.

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Q. No. 4 (Page 2)

Area of ΔOAB = Electrical potential energy.

Electrical P.E = $\frac{1}{2}$ Base x height.

As the base is q and heigh is V so,

Electrical P.E = $\frac{1}{2}$ qV.

$q = CV$ so,

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

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

As, $V = Q/C$ so,

$= \frac{1}{2} C (Q/C)^2$

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

Electrical P.E = $Q^2/2C$

b. GIVEN: Energy = ?

$q = 5C.$

$V = 15V.$

SOLUTION:

Energy = $\frac{1}{2} qV$

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Q. No. 4 (Page 3) putting the values,

Energy = $\frac{1}{2}(5)(15)$.

Energy = 37.5 J

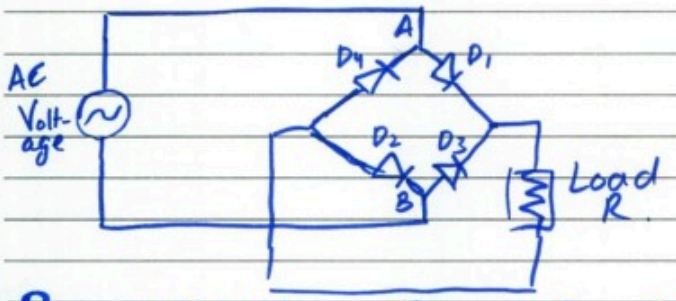
So, the energy stored will be 37.5 Joules.

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Q. No. 5 (Page 1)

WORKING OF A BRIDGE RECTIFIER:

A bridge rectifier uses four diodes to convert the complete cycle of AC into DC voltage. Hence it conducts full wave rectification. Its construction or circuit is shown below:

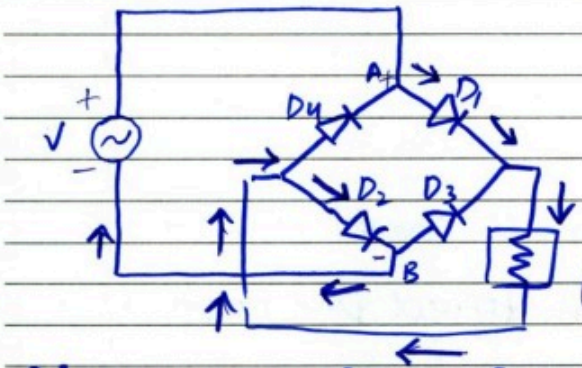


POSITIVE HALF CYCLE OF AC:

During the positive half cycle of the secondary voltage, the end A becomes positive so the diodes (D_1, D_2) become forward biased while the diodes D_3, D_4 become reverse biased. Hence D_1, D_2 allow current to flow while diodes D_3, D_4 donot allow current to flow. The current flows from D_1 to load resistor then to D_2 and then returns to the battery through the negative end. This can be shown by the circuit diagram:

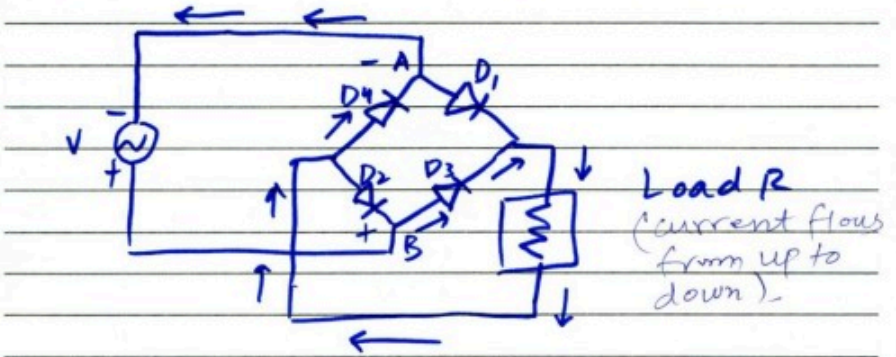
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Q. No. 5 (Page 2)



NEGATIVE HALF CYCLE OF AC:

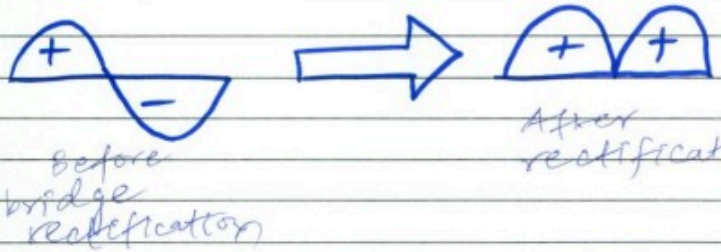
During the negative half cycle of AC, the end A becomes negative while the end A becomes positive. D_3 and D_4 become forward biased while D_1 and D_2 become negative biased. Current from from D_3 to Load R (downward direction) and then returns to the battery.



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Q. No. 5 (Page 3)

CONCLUSION: It is apparent that current flows through the diodes during both half cycles of AC. One pair of diodes conduct during positive half cycle while the other pair conducts during negative half cycle. The current flowing through the load resistor **is in the same direction** (up to down) during both half cycles. So **rectified DC voltage** is obtained using a bridge rectifier. The waveform is given below:



Before bridge rectification

After rectification

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Q. No. 6 (Page 1)

LUMINOSITY: (of a star).

Luminosity (L) is the total **power output** of the radiation emitted by a star. It is a measure of the electromagnetic energy emitted by a star per unit time.

$L = \text{Power} = E/t$.

SI UNIT:

The SI unit of Luminosity is: **Watt or Js^{-1}**. (joules per second).

RELATION BETWEEN L, radius & TEMPERATURE:

The relation between luminosity, ~~radiation~~ radius and temperature can be found using

Stefan boltzmann law:

"The total amount of electromagnetic energy emitted by a ~~star~~ blackbody per unit area per second is proportional to fourth power of the absolute temperature of the body".

$$\frac{E}{A \cdot t} \propto T^4$$

$$P/A \propto T^4$$

$$P/A = \sigma T^4$$

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Q. No. 6 (Page 2)

$P = \sigma T^4 A$

Since P = Luminosity:

$L = A\sigma T^4$

where σ is the stefan-boltzmann constant with a value of $5.67 \times 10^{-8} Wm^{-2}K^{-4}$.

For a star (a sphere) the area = $4\pi R^2$ so,

$L = 4\pi R^2 \sigma T^4$

Hence this is the relation between luminosity radius and temperature.

b. GIVEN:

Relative luminosities ($\frac{L_A}{L_B} = ?$).

$T_A = 100K$. $T_B = 200K$.

$R_A = 10m$ $R_B = 5m$.

SOLUTION:

$L_A = 4\pi R_A^2 \sigma T_A^4 \longrightarrow (i)$

$L_B = 4\pi R_B^2 \sigma T_B^4 \longrightarrow (ii)$

÷ing L_A by L_B:

$\frac{L_A}{L_B} = \frac{4\pi R_A^2 \sigma T_A^4}{4\pi R_B^2 \sigma T_B^4}$

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Q. No. 6 (Page 3)

$$= \frac{R_A^2 T_A^4}{R_B^2 T_B^4}$$

$$= \frac{(10)^2 (100)^4}{(5)^2 (200)^4}$$

$$= \frac{1 \times 10^{10}}{4 \times 10^{10}}$$

$$\frac{L_A}{L_B} = \frac{1}{4} = 0.25$$

$$L_B = 4L_A$$