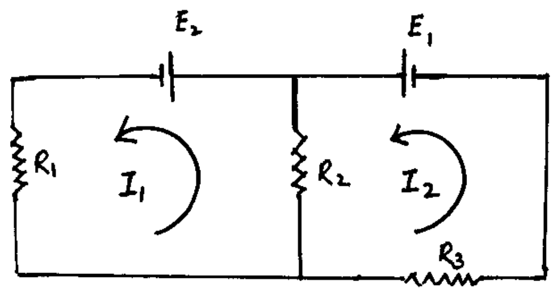
Federal Board HSSC – II Examination
Physics – Mark Scheme

SECTION B

Q.2 **(2)**

Circuit



(1 mark)

$-I_1R_1-E_2-(I_1-I_2)R_2 = 0$

(OR)

$-I_1R_1+E_2-(I_1-I_2)R_2 = 0$

and

$-(I_2-I_1)R_2-I_2R_3+E_1 = 0$

(OR)

$-(I_2-I_1)R_2-I_2R_3-E_1 = 0$ (1 mark)

Q.3 **(2)**

i. Soft iron can be magnetized and demagnetized easily. (1 mark)

ii. Hysteresis loss for soft iron is small. . (1 mark)

Q.4 **(2)**

$X_c = \frac{1}{\omega c} = \frac{1}{2\pi fc}$

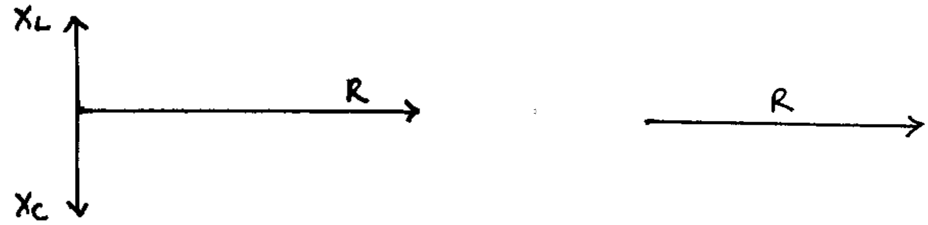
$\therefore X_c \propto \frac{1}{f}$

and $X_L = \omega L = 2\pi fL$

$\therefore X_L \propto f$ (1 mark)

With the increase of frequency, reactance of a capacitor decreases whereas reactance of an inductor increases and vice versa (1 mark)

Q.5 **(2)**



(1 mark)

At resonance the impedance of the circuit is resistive. Therefore current and voltage are in phase i.e. θ = o^0. The power factor (Cosθ = coso^0) is 1. (1 mark)

Q.6 **(2)**

$X = \overline{A\overline{B} + \overline{A}B}$ (1 mark)

When

A = 0 & B = 0

Then $X = \overline{0 \cdot 1 + 1 \cdot 0} = 1$ (1 mark)

Q.7 **(2)**

In a transistor E – B Junction is always forward biased, so, small V_{BB} is required (1 mark)

and B – C Junction is reverse biased, so V_{CC} is taken high. (1 mark)

Q.8 **(2)**

Equation for de-Broglie wavelength

$\lambda = \frac{h}{P} = \frac{h}{mv}$ (1 mark)

For macroscopic objects ‘ ’ is v.v. small which cannot be observed. (1 mark)

Q.9 **(2)**

In the production of x-rays, electrons are incident on the target material, which gives a large amount of KE to the target and target material will become very hot which may melt, so we use a target of high M.P. (2 marks)

Q.10 **(2)**

Mass defect

$\Delta M = M_p + M_N - M$ (nucleus) (1 mark)

According to Einstein’s equation

$E = \Delta MC^2$

This additional mass changes into B.E of the atom. (1 mark)

Q.11 **(2)**

Magnetic force on a charged particle when projected at right angles into a magnetic field is

$\vec{F} = q(\vec{V} \times \vec{B})$ (i.e. $\theta = 90°$)

or $F = q\,V\,B\,\sin 90°$

$F = q\,V\,B$ (1 mark)

'F' provides necessary centripetal force to the charged particles.

Therefore they follow a circular path. (1 mark)

Q.12 **(2)**

γ-rays are coming out from the nucleus of an unstable atom. (1 mark)

X-rays are obtained by the inner shell transition of electrons. (1 mark)

Q.13 **(2)**

As $V = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r}$ (1 mark)

$q = -4\mu C = -4 \times 10^{-6} C$

$r = 20cm = 0.2m$

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^{9} Nm^2C^{-2}$

$V = \frac{9\times10^9\,Nm^2C^{-2}\times(-4\times10^{-6}C)}{(0.2m)^2} = -9\times10^5\,Volt$ (1 mark)

Q.14 **(3)**

$I = 1.2A$

$A = 10^{-4}m^2$

$n = 5 \times 10^{28}m^{-3}$

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

$\upsilon = ?$

$I = nqA\upsilon$ (1 mark)

$\upsilon = \frac{I}{nqA} = \frac{1.2}{5\times10^{28}\times1.6\times10^{-19}\times10^{-4}} = 1.5\times10^{-6}\,ms^{-1}$ (2 marks)

(OR)

Since the electron and proton possess same momentum

$m_e\upsilon_e = m_p\upsilon_p$

$\frac{\upsilon_e}{\upsilon_p} = \frac{m_p}{m_e}$ (1)

Force (F_B) due to magnetic field provides Fc i.e. $F_c = F_B$

$\frac{m\upsilon^2}{r} = Be\upsilon$

$\upsilon = \frac{Ber}{m}$ (1 mark)

Then $$\frac{\upsilon_e}{\upsilon_p} = \frac{\frac{B_e r_e}{m_e}}{\frac{B_e r_p}{m_p}}$$

$$\frac{\upsilon_e}{\upsilon_p} = \frac{r_e}{r_p} \times \frac{m_p}{m_e}$$

$$\frac{r_e}{r_p} = \frac{\upsilon_e}{\upsilon_p} \times \frac{m_e}{m_p}$$

$\frac{r_e}{r_p}$ =1 using equation (1) (2 marks)

Q.15 **(3)**

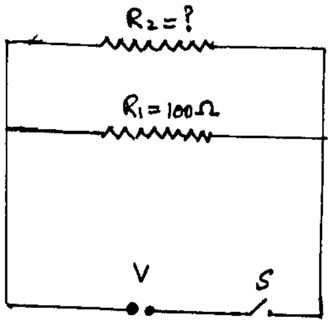
To get a resultant of 60Ω, which is less than 100Ω, a resistor R_2 is connected in parallel to R_1 = 100Ω

Then

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow \frac{1}{R_2} = \frac{1}{R} - \frac{1}{R_1}$$

$$\frac{1}{R_2} = \frac{1}{60} - \frac{1}{100} = \frac{5-3}{300} = \frac{2}{300} = \frac{1}{150}$$

R_2 = 150Ω (2 marks)



(1 mark)

(OR)

F = qυB = Beυ (θ = 90°)

$$\frac{m\upsilon^2}{r} = Be\upsilon$$

υ = $\frac{Ber}{m}$ (1 mark)

ύ = $\frac{(4B)er}{m} = 4\upsilon$ (θ $B' = 4B$)

As E = $\frac{1}{2}m\upsilon^2$

É = $\frac{1}{2}m(v')^2 = \frac{1}{2}m(4\upsilon)^2$

É = 16 $\left(\frac{1}{2}m\upsilon^2\right)$

É = 16E (2 marks)

Q.16 **(3)**

$P = \frac{V^2}{R_e}$

$P = \frac{V^2}{3R} = 10W$ $\quad$ (θ R_e = 3R) (1 mark)

When connected in parallel

$R_e = \frac{R}{3}$

$P' = \frac{V^2}{R/3} = 3\times\frac{V^2}{R} = 9\left(\frac{V^2}{3R}\right) \Rightarrow P' = 9P$

$P' = 9 \times 10W$ $\quad$ (θ P=10W)

$P' = 90W$ (2 marks)

(OR)

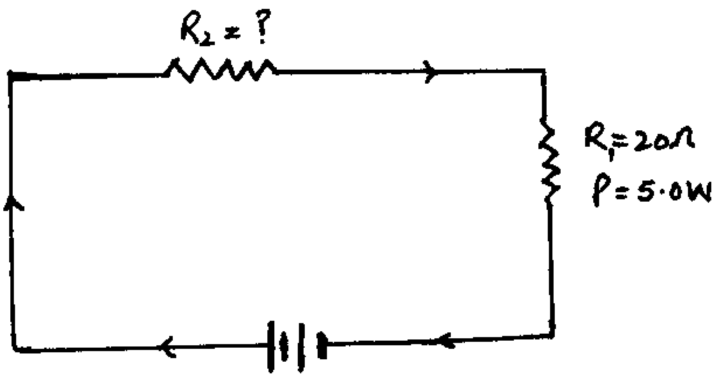
Energy of light = # of photons $\times$ Energy of one photon

$E = nhf$ (1 mark)

$n = \frac{E}{hf} = \frac{E\lambda}{hc}$ (1 mark)

$n = \frac{1\times10^{-18}\times600\times10^{-9}}{6.63\times10^{-34}\times3\times10^{8}} = 3$ (1 mark)

Q.17 **(3)**



Since

$P = I^2R_1$

$I^2 = \frac{P}{R_1} \Rightarrow I = \sqrt{\frac{P}{R_1}} = \sqrt{\frac{5}{20}} = 0.5A$ (1 mark)

As R = $\frac{V}{I} = \frac{24V}{0.5A} = 48\Omega$

R = $R_1 + R_2$ $\therefore$ $R_2 = R - R_1$

$R_2 = 48\Omega - 20\Omega$

$R_2 = 24\Omega$ (2 marks)

(OR)

For a solenoid of length 'l', cross-sectional area 'A' & # of turns 'N'

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t} = -N\frac{\Delta(BA)}{\Delta t}$$

$$\varepsilon = -NA\frac{\Delta B}{\Delta t}$$ (1 mark)

$B = \mu_o nI = \mu_o \frac{N}{l} I$ (for a solenoid)

$$\varepsilon = -NA\frac{\Delta(\mu_o \frac{N}{l} I)}{\Delta t}$$

$$\varepsilon = \frac{-NA\mu_o}{l} \times \frac{\Delta I}{\Delta t}$$ (1)

Using

$$\varepsilon = -L\frac{\Delta I}{\Delta t}$$ (2) (1 mark)

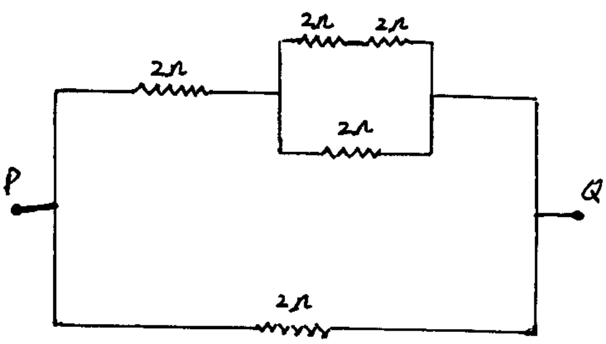
Comparing equation (1) and (2)

$$\cancel{-}L\cancel{\frac{\Delta I}{\Delta t}} \cancel{=} \frac{-\mu_o N^2 A}{l}\cancel{\frac{\Delta I}{\Delta t}}$$

$$L = \mu_o \frac{N^2}{l} A = \mu_o n^2 l A = \mu_o n N A$$ (1 mark)

Which is the required expression

Q.18 **(3)**



For R_1 & R_2 let their resultant be $R' = 4\Omega$

Resultant of $R' \& R_3$ connected in parallel is $R'' = \frac{4\times 2}{4+2} = \frac{4}{3}\Omega$ (1 mark)

R'' & R_4 are in series their resultant is $R''' = \left(\frac{4}{3} + 2\right) = \frac{10}{3}\Omega$

Resultant of R''' & R_5 connected in parallel is R = $\frac{2\times\frac{10}{3}}{\frac{10}{3}+2} = \frac{20/3}{16/3} = \frac{20}{16} = 1.25\Omega$

(2 marks)

(OR)

R = $\rho\frac{L}{A} = \rho\frac{4L}{\pi d^2}$

V = IR = I $\rho\frac{4L}{\pi d^2}$ (1 mark)

For the wire 'x' $V_x = I_x\ \rho\frac{4L}{\pi d_x^2}$

For the wire 'y' $V_y = I_y\ \rho\frac{4L}{\pi d_y^2}$

$V_x = V_y$ (as the wires are connected in parallel)

$I_x.\ \rho\frac{4L}{\pi d_x^2} = I_y \times\rho\frac{4L}{\pi d_y^2}$

$\frac{I_x}{d_x^2} = \frac{I_y}{d_y^2}$

$\frac{4I_x}{d_y^2} = \frac{I_y}{d_y^2}$ as $d_x = \frac{d_y}{2}$

$\Rightarrow I_y = 4I_x$

Fraction of current which passes

through 'x' = $\frac{I_x}{total\,current} = \frac{I_x}{I_x + I_y} = \frac{I_x}{5I_x} = \frac{1}{5} = 0.20$ (2 marks)

Q.19 **(3)**

The combined capacitance 'C' is given by

C = $\frac{C_1\times C_2}{C_1 + C_2} = \left(\frac{3.0\times6.0}{3.0+6.0}\right)\mu F = 2.0\mu F = 2.0\times10^{-6}F$ (1 mark)

Net charge stored

Q = CV = $2.0 \times 10^{-6} \times 18$

Q = 36×10^{-6}C (1 mark)

For capacitors connected in series, charge is same. (1 mark)

(OR)

$(KE)_{max} = Ve$

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

$mv = \sqrt{2mVe}$

Now $\lambda = \frac{h}{P} = \frac{h}{mv} = \frac{h}{\sqrt{2mVe}}$ (1 mark)

$$\lambda = \frac{6.63\times10^{-34}}{\sqrt{2\times9.11\times10^{-31}\times100\times1.6\times10^{-19}}}$$

$$\lambda = 1.22\times10^{-10}\,m$$ (1 mark)

In the electromagnetic spectrum this would be X–Radiation. (1 mark)

SECTION C

Q.20 **(8)**

- Need of transformer (1 mark)
- Explanation and working principle + figure (2 marks)
- Transformer equation + step up + step down (3 marks)
- Power losses and their remedies (2 marks)

Q.21 **(8)**

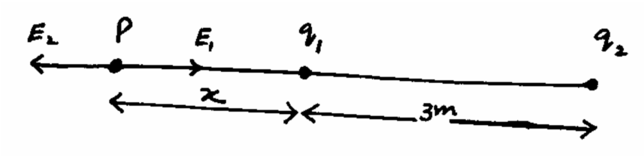
a. Statement of Gauss's law (1 mark)

Explanation of Gauss's law using spherical body + figure (2 marks)

Derivation for electric field $= \frac{\sigma}{2\varepsilon_o}\hat{r}$ + Figure (2 marks)

b.

(1 mark)



Obviously, the zero field location will be at pt. P

$E_1 = E_2$

$$\frac{1}{4\pi\varepsilon_o}\frac{q_1}{x^2} = \frac{1}{4\pi\varepsilon_o}\times\frac{q_2}{(x+3)^2}$$ (1 mark)

$$\frac{1\times10^{-6}}{x\upsilon} = \frac{4\times10^{-6}}{(x+3)^2}$$

$(x+3)^2 = 4x^2$

$x+3 = 2x$

$x = 3m$ (1 mark)

Q.22 **(10)**

a. Definition (1 mark)

Construction + figure + working (1+1+2 = 4 marks)

b. Sensitivity factor + methods to increase the sensitivity

(1+2 = 3 marks)

c. Diagram for ammeter (1 mark)

Diagram for voltmeter (1 mark)

(OR)

a. Definition (1 mark)
Explanation + figure (2 marks)
Results (1 mark for each result) (3 marks)

b. $\lambda = 300\text{nm} = 300 \times 10^{-9}\text{m}$

$\phi = 2.46\text{ev} = 2.46 \times 1.6 \times 10^{-19}\text{J}$

$(KE)_{max} = hf - \phi = \frac{hc}{\lambda} - \phi$

$(KE)_{max} = \frac{6.63\times10^{-34}\times3\times10^{8}}{300\times10^{-9}} - 2.46\times1.6\times10^{-19}$

$(KE)_{max} = (6.63 \times 10^{-19} - 3.936 \times 10^{-19})\text{J}$

$(KE)_{max} = 2.693 \times 10^{-19}\text{J}$

$(KE)_{max} = 1.68\text{ev}$ (2 marks)

$\phi = hf_o = \frac{hc}{\lambda_o}$

$\lambda_o = \frac{hc}{\phi} = \frac{6.63\times10^{-34}\times3\times10^{8}}{2.46\times1.6\times10^{-19}}$

$\lambda_o = 5.05\times10^{-7}\,m$

$\lambda_o = 505nm$ (2 marks)