HSE Examination March 2021

PHYSICS

1) charges, square

2) (ii) Gauss law in magnetism

3) (ii) UV rays

4) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

5) polarisation

6) $\lambda = \frac{h}{p}$ or $\lambda = \frac{h}{mv}$

7) 13.6 eV

8) $4a_0$ (Hint: $r_n = n^2 a_0$)

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9) $V = \frac{1}{4\pi\epsilon_0}\frac{q}{r} = 9\times10^9 \times \frac{4\times10^{-7}}{9\times10^{-2}}$

$= 4\times10^4\ V$

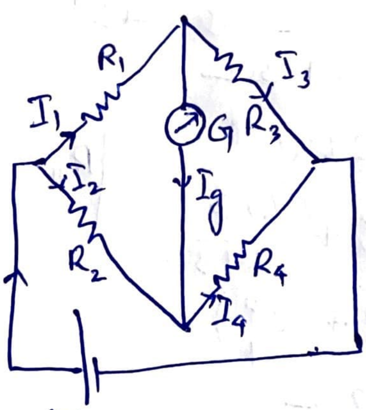
10) Statement

$dB \propto \frac{I\,dl\,\sin\theta}{r^2}$

OR

$dB = \frac{\mu_0}{4\pi}\frac{I\,dl\,\sin\theta}{r^2}$

11)



when bridge is balanced $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

12) Metre bridge is balanced

$\frac{R_1}{l} = \frac{R_2}{(100-l)}$

$\frac{R}{40} = \frac{3}{60} \Rightarrow R = 2\Omega$

13) a) strongest force in universe

b) It is a short range force

c) It is charge independent

14) It is the time required to reduce the quantity of radio-active nuclei into half of the present value.

$T_{1/2} = \frac{0.693}{\lambda}$

15) $n = 1000$

$I = 2A$

$H = nI = 2000\ A/m$

16) a) Substance Q

b) negative. (Diamagnetic)

17) $dI = I_2 - I_1 = 0.0 - 5.0 = -5$

$dt = 0.1$ sec

$e = 200$

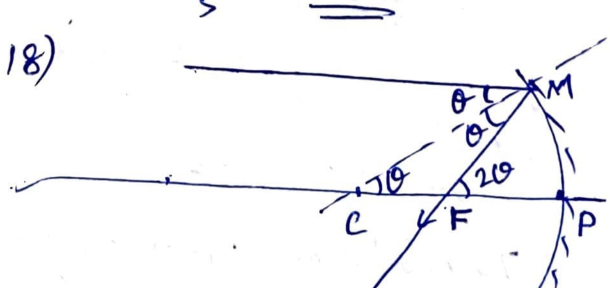
$e = -L\frac{dI}{dt}$ | $e = -\frac{d\phi}{dt}$

$200 = -L \times \frac{-5}{0.1}$

$= 50L$

$L = \frac{200}{5} = 4\ H$

18)



For $\angle MCP$, $\theta = \frac{PM}{PC} = \frac{PM}{R}$ — ①

for $\angle MFP$, $2\theta = \frac{PM}{PF} = \frac{PM}{f}$

$\theta = \frac{PM}{2f}$ — ②

① & ② $\Rightarrow$ $R = 2f$

19) $R = 484\Omega$

$V = 220V$

$I_{rms} = \frac{V}{R} = \frac{220}{484} = 0.45A$

$I_{rms} = \frac{I_0}{\sqrt{2}} \Rightarrow I_0 = \sqrt{2} \times I_{rms}$

$= \sqrt{2} \times 0.45$

$= 0.64V$

20) Any two postulates

OR

$L = \frac{nh}{2\pi}$ and $h\nu = E_i - E_f$

21) OR gate

A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

22) a) Eddy current

b) (1) Magnetic breaking in trains

2) Induction furnace

3) Electric power meter

23) a) $P = q \times 2l$

b) $q = 2.5 \times 10^{-7}$

$2l = 2 \times 15 = 30$ cm.

(The charges are on the z axis)

$P = q \times 2l$

$= 2.5 \times 10^{-7} \times 30 \times 10^{-2}$

$= 75 \times 10^{-9}$ cm from $-q$ to $+q$

ie, from (0,0,+15) to (0,0,−15)

24) a) 1) Start from +ve and end at −ve

2) It will not produce closed loop

3) They will not intersect.

b) q_1 +ve ; q_2 −ve

25) Derivation of $U = \frac{1}{2}CV^2$

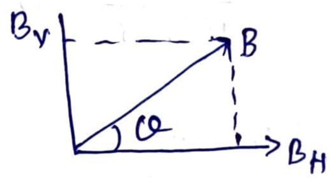
26) polar – positive and −ve charge centres do not coincide

eg : H_2O

Non-polar – +ve and −ve charge centres coincide

Eg : O_2

27) a) It is the angle that the magnetic field of earth at a point makes with the horizontal.



b) $B_H = B\cos\theta$

$B_V = B\sin\theta$

$B_V = B_H \Rightarrow \sin\theta = \cos\theta$

$\Rightarrow \theta = 45°$

28) a) 6Ω and 3Ω

b) $V = 24V$

$R = 8 + \left(\frac{6 \times 3}{6+3}\right)$

$= 8 + \left(\frac{18}{9}\right)$

$= 10\Omega$

$R_{\parallel} = \frac{R_1 R_2}{R_1 + R_2}$

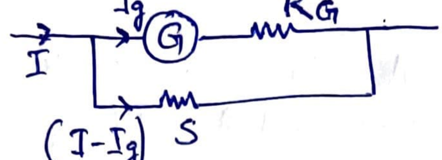
$I = V/R = \frac{24}{10} = 2.4A$

29) Derivation of $B = \mu_0 n I$

⋮

(3)

30)



Galvanometer can be converted to ammeter by connecting a shunt resistance in parallel to galvanometer

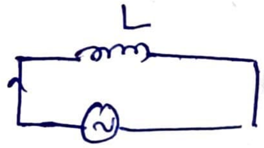
Since G and S are parallel, Potential difference across both are same,

$$I_g \times R_G = (I - I_g)S$$

Shunt to be connected is,

$$S = \frac{I_g \times R_G}{I - I_g}$$

31)



$E = E_0 \sin\omega t$

By kirchoff's rule,

$$E - L\frac{dI}{dt} = 0$$

$$\frac{dI}{dt} = \frac{E}{L} = \frac{E_0 \sin\omega t}{L}$$

$$dI = \frac{E_0 \sin\omega t \, dt}{L}$$

$$I = \int \frac{E_0}{L} \sin\omega t \, dt$$

$$= \frac{E_0}{L} \times \frac{-\cos\omega t}{\omega}$$

$$= \frac{E_0}{L\omega} \times \sin(\omega t - \pi/2)$$

$$= I_0 \sin(\omega t - \pi/2)$$

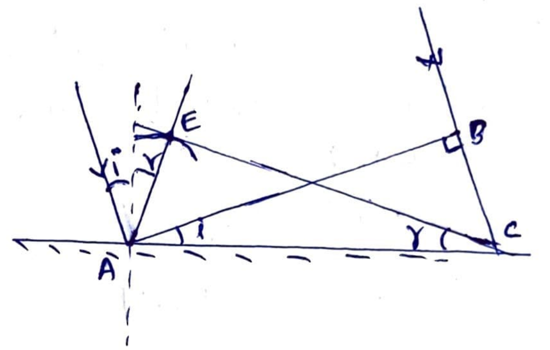
ie, I lags by $\pi/2$

32) a) Displacement current

b) $B_0 = \frac{E_0}{c}$

$= \frac{6.3}{3 \times 10^8} = 2.1 \times 10^{-8}$ T

33)



For the incident with velocity v

BC = vt — ①

For reflected wave front, draw a sphere of radius vt from A and CE is the tangent to the sphere.

∴ AE = BC = vt

Now △les EAC and BAC are congruent. ⇒ i = r.

34) a) $h\nu = \phi_0 + \frac{1}{2}mv^2$

OR any correct relation

b) $KE_{max} = \frac{1}{2}mv^2 = h\nu - \phi_0$

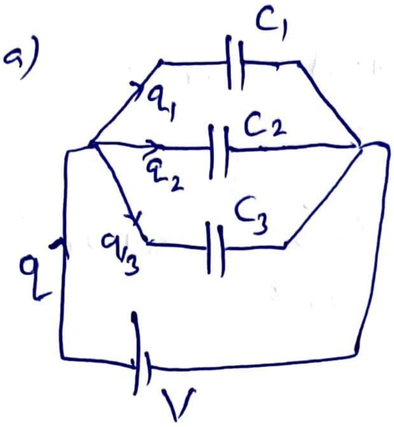
KE_{max} is independant on intensity and depends on fresuency of incident light.

Since KE_{max} is always +ve, emission is possible only if $h\nu > \phi_0$

ie, $h\nu > h\nu_0$

ie, $\nu > \nu_0$

35) a)



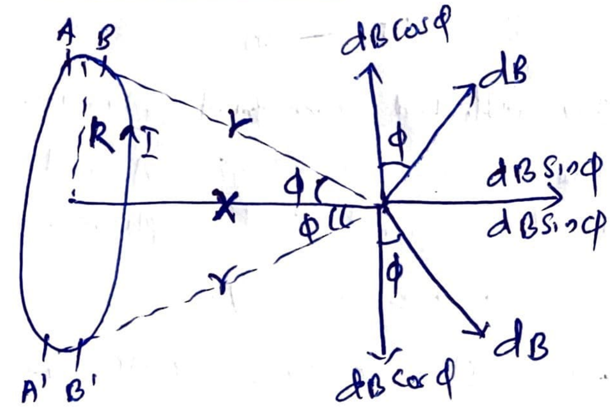
Since they are parallel, p.d across each capacitor same, but charge is distributed.

$$q = q_1 + q_2 + q_3.$$

$$CV = C_1V + C_2V + C_3V$$

$$\boxed{C_p = C_1 + C_2 + C_3}$$

36)



magnetic field due to current element AB,

$$dB = \frac{\mu_0}{4\pi}\frac{I\,dl\sin 90}{r^2}$$

$$= \frac{\mu_0}{4\pi}\frac{I\,dl}{r^2} \quad \text{—①}$$

|||ly magnetic field due to A'B'.

$$dB = \frac{\mu_0}{4\pi}\frac{I\,dl}{r^2} \quad \text{—②}$$

The components $dB\cos\phi$'s cancell out

The horizontal components $dB\sin\phi$'s add up

For all the current elements in the loop, total field,

$$\sin\phi = \frac{R}{r}$$
$$r = (x^2+R^2)^{\frac{1}{2}}$$

$$B = \sum dB\sin\phi$$

$$= \sum \frac{\mu_0}{4\pi}\frac{I\,dl}{r^2} \times \frac{R}{r}$$

$$= \frac{\mu_0}{4\pi}\frac{IR}{(x^2+R^2)^{3/2}}\sum dl$$

$$= \frac{\mu_0}{4\pi}\frac{IR}{(R^2+x^2)^{3/2}} \times 2\pi R$$

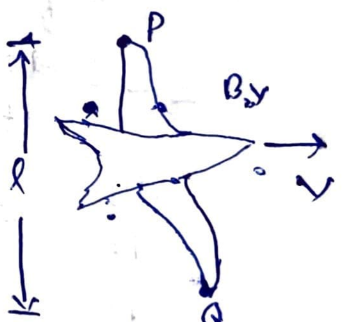
$$= \frac{\mu_0}{2}\frac{I R^2}{(R^2+x^2)^{3/2}}$$

For N turns,

$$\boxed{B = \frac{\mu_0}{2}\frac{NIR^2}{(R^2+x^2)^{3/2}}}$$

37) a) Energy

b)



$V = 1800$ km/h

$= 1800 \times \frac{5}{18}$ m/s

$= 500$ m/s

Motional emf, btw ends of wings,

$$V_m = Blv$$

$$= 2.9\times10^{-4} \times 25 \times 500$$

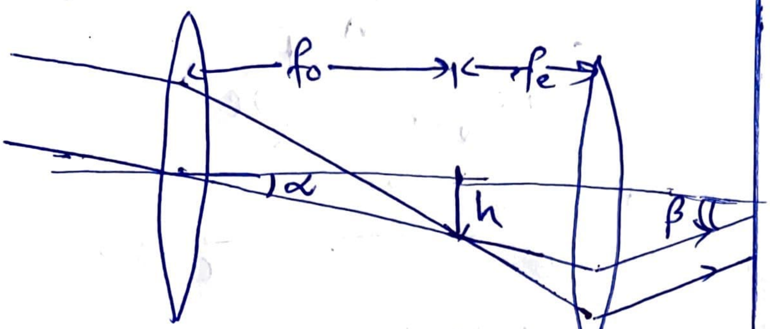
$$= 362.5\times10^{-2}$$

$$= 3.625 \text{ V}$$

38) Derivation of

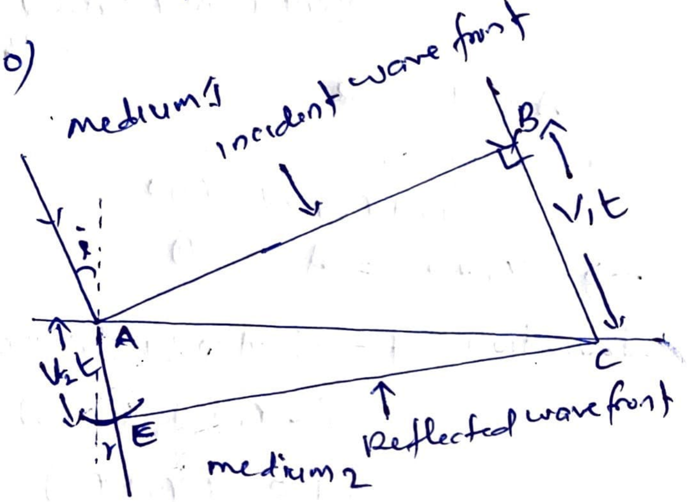
$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2-n_1}{R}$$

39)



$L = f_o + f_e$

40)



For the incident wave AB, moving with velocity, V_1 in medium 1

$BC = V_1 t$

For getting the shape of reflected wave draw a sphere of radius $V_2 t$ from point A in medium 2 and let CE be the tangent from C onto the sphere. then $AE = V_2 t$ and CE is refracted wave front.

Now Δles ABC and AEC gives.

$$\sin i = \frac{BC}{AC} = \frac{V_1 t}{AC}$$

$$\sin r = \frac{AE}{AC} = \frac{V_2 t}{AC}$$

$$\frac{\sin i}{\sin r} = \frac{V_1}{V_2}$$

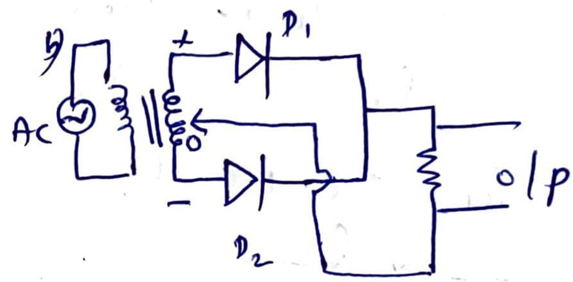
But $n_1 = \frac{c}{V_1}$

$n_2 = \frac{c}{V_2}$

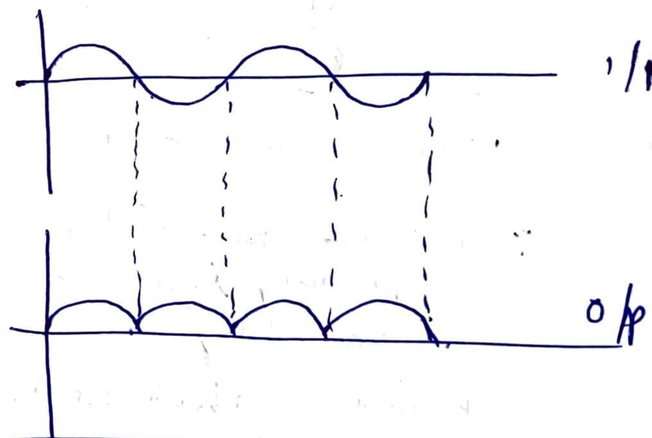
$\therefore \frac{V_1}{V_2} = \frac{n_2}{n_1}$

$$\therefore \boxed{\frac{\sin i}{\sin r} = \frac{V_1}{V_2} = \frac{n_2}{n_1}}$$

41) a) Fig 1



Explanation.



42) a) True

b) Statement OR $\phi_E = \frac{q}{\varepsilon_0}$

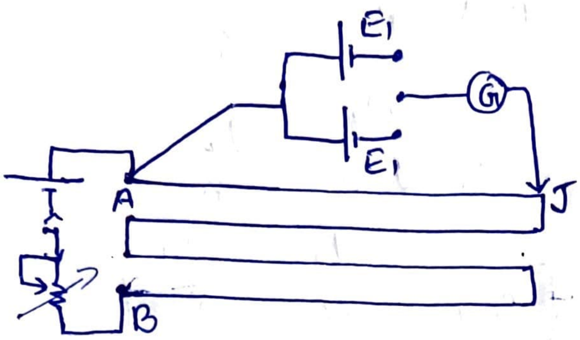
c) Derivation of $E = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$

43) a) $V \propto l$

OR

$E \propto l$

43) b)



when E_1 is connected to the circuit and let l_1 be the balancing length, then,

$E_1 \propto l_1$

||ly for second cell,

$E_2 \propto l_2$

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

44) a) ~~c~~ Mutual inductance

b) Step up – No. of turns in primary less than secondary

Step down – Thickness is primary less then secondary

c) $\frac{V_s}{V_p} = \frac{N_s}{N_p}$

$V_p = 3300$ V

$N_p = 6000$

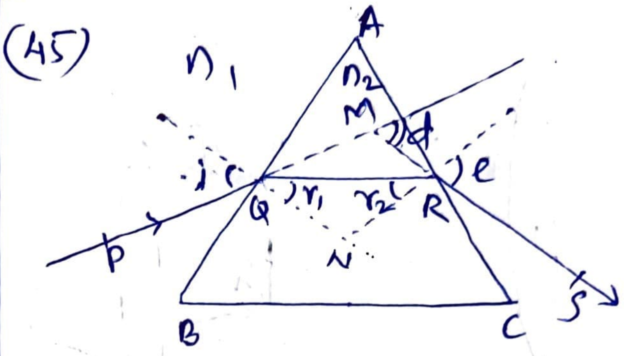
$N_s = ?$

$V_s = 220$ V

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

$= \frac{220}{3300} \times 6000 = 400$

(45)



For ▱ AQNR,

$A + \angle AQN + N + \angle ARN = 360$

$A + N = 180$

For △ QNR,

$r_1 + r_2 + N = 180$

$\Rightarrow r_1 + r_2 = A$ —— ①

deviation, $d = \angle MQR + \angle MRQ$

$= (i - r_1) + (e - r_2)$

$= i + e - (r_1 + r_2)$

$= i + e - A$ —— ②

As i increase, d decreases first reaches minimum and then increases

when, $d = d_{min} = D$

$i = e$

$r_1 = r_2 = r$

QR parallel to BC

∴ ① ⇒ $2r_1 = A \Rightarrow r_1 = A/2$

② $D = 2i - A$

$i = \frac{A+D}{2}$

∴ Snells law for surface AB, is

$$\frac{n_2}{n_1} = \frac{\sin i}{\sin r_1} = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin(A/2)}$$

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