Class :XII || CBSE|| Set-02 || Pre Board Examination , 2024-25
Subject : Physics ||Full marks : 70||Time : Three hours

(The figures in the margin indicate full marks for the questions)

Section A [Each question carries 1 mark]

1.The total electric flux through the faces of the cube with side of length 'a' if a charge q is placed at the centre of the cube is

(a) $q/ 8\varepsilon_0$ (b) q/ ε_0 (c) $q/6\varepsilon_0$ (a) $q/ 4\varepsilon_0$

Ans-(c)

2. If n cells each of emf ε and internal resistance r are connected in parallel, then the total emf and internal resistance will be

(a) ε , r/n (b) ε , nr (c) $n\varepsilon$, r/n (d) $n\varepsilon$, nr

Ans-(a)

3.The maximum current that can be measured by a galvanometer of resistance 40 Ω is 10 mA . It is converted into voltmeter that can read upto 50 V. The resistance to be connected in the series with the galvanometer is

(a) 2010 Ω (b) 4050 Ω (c) 5040 Ω (d) 4960 Ω

Given - G = 40Ω, I_g = 10 mA = 10 × 10^{-3} A, and V = 50V

The voltage during conversion is given by $\Rightarrow V = i_g (G + R)$

The above equation can be rewritten for R as

$$\Rightarrow R = \frac{V}{I_g} - G = \frac{50}{10\times10^{-3}} - 40 = 5000 - 40 = 4960\,\Omega$$

4. A transformer is employed to

(a) Obtain a suitable dc voltage

(b) Convert dc into ac

(c) Obtain a suitable ac voltage

(d) Convert ac into dc

Ans- ©

5. cutting a bar magnet into half is like cutting a solenoid. We get two smaller solenoids

(a) with stronger magnetic properties.

(b) with weaker magnetic properties.

(c) with semi magnetic properties.

(d) none of these.

Ans-(b)

6. A transformer is used to light a 100 W and 110 V lamp from a 220 V mains. If the main current is 0.5 A, the efficiency of the transformer is approximately

(a) 30 % (b) 50 % (c) 90 % (d) 10 %

Given,

The mains current is 0.5A.

The mains voltage is 220V .

Power of light = 100W and voltage V = 110V

The efficiency is $n = \frac{\text{output}}{\text{input}} \times 100 = \frac{100}{220 \times 0.5} \times 100 = 90.9$

The approximate efficiency of transformer is 90%.

7. 1eV is energy acquired by an electron when it is accelerated through potential difference of –

(a) 1 V (b) 10 V (c) 0.1 V (d) none of these

Ans- (a)

8. In a coil of self-induction 5 H, the rate of change of current is 2 A/s. Then emf induced in the coil is

(a) 10 V (b) 5 V (c) −5 V (d) −10 V

Given : Inductance of the coil (L) = 5 H and rate of change of current (dI/dt) = 2A/s.

The induced e.m.f = -L(dI/dt) = -5 x 2 = -10 V

9. A particle is dropped from a height H. The de Broglie wavelength of the particle as a function of height is proportional to

(a) H (b) $H^{1/2}$ (c) H^{0} (d) $H^{-1/2}$

A particle is dropped from a height H

$$H = v = \sqrt{2gH}$$

We know that de-Broglie wavelength $\lambda = \frac{h}{p}$

$$\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{2gH}}$$

h, m and g are constant

$$\therefore \frac{h}{m\sqrt{2g}} \text{ is constant} \Rightarrow \lambda \propto \frac{1}{\sqrt{H}} \Rightarrow \lambda \propto H^{-\frac{1}{2}}$$

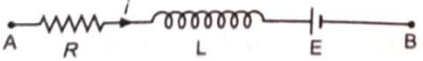
10. By what factor must the mass number change for the nuclear radius to become twice?

(a) 3^3 (b) 4^3 (c) 2^3 (d) 5^3

Ans-(c)

11. In the circuit diagram shown, R = 10 Ω , L = 5 mH , E = 10 V and ***i*** = 1A. The current is decreasing at the rate

of 10^3 A/s. Then (V_A — V_B) at this instant is



(a) 10 V (b) 15 V (c) 20 v (d) 25 V

PD across inductor,

$$V_L = L\frac{di}{dt} = (5)(-1.0) = -5V$$

now, $V_a - iR - V_L = E = V_b$

$$\therefore V_{ab} = V_a - V_b = E + iR + V_L = 20 + (2)(10) - 5 = 35V$$

12. The spacing between field lines indicates its

_____

(a)charge (b)position

(c)strength (d) none of above

Ans- (c)

For Q. 13 to Q. 16 :Two statements are given-one Assertion (A) and the other Reason .Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) If both Assertion and Reason are true and Reason is correct explanation Of Assertion.

(b) If both Assertion and Reason are true but Reason is not the correct explanation Of Assertion.

(c) If Assertion is true but Reason is false.

(d) If both Assertion and Reason are false.

13. Assertion (A): A spherical equipotential surface is not possible for a point charge.

Reason (R): A spherical equipotential surface is not possible inside a parallel plate capacitor.

Ans- (d)

14. Assertion (A): To observe diffraction of light, the size of the obstacle/aperture should be Of the order of 10^{-7} m.

Reason (R): 10^{-7} m is the order of the wavelength of visible light.

Ans-(a)

15. Assertion (A): de Broglie equation is significant for microscopic particles.

Reason (R): de Broglie wavelength is inversely proportional to the mass of a particle when velocity is kept constant.

Ans-(a)

16. Assertion (A): When an electron falls from a higher energy to a lower energy' level, the difference in the energies appears in the form of electromagnetic radiation. It can't emit as other forms of energy.

Reason (R): Electrons interact electromagnetically only.

Ans-(a)

SECTION - B[Each question carries 2 marks]

17. A plane electromagnetic wave travels in vacuum along z-direction. What can you say about the directions of its electric and magnetic field vectors? If the frequency of the wave is 30 MHz, what is its wavelength?

The electromagnetic wave travels in a vacuum along the z-direction.

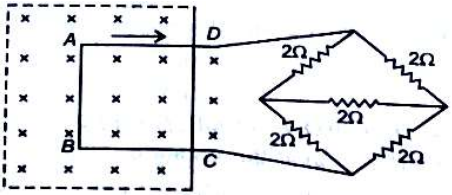
The electric field (E) and the magnetic field (H) are in the x-y plane and mutually perpendicular.

Frequency of the wave, $\nu = 30\ \text{MHz} = 30 \times 10^6\ \text{s}^{-1}$

Speed of light in a vacuum, $c = 3 \times 10^8\ \text{m/s}$

Wavelength of a wave is given as: $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{30 \times 10^6} = 10\ \text{m}$

18. A metallic square loop ABCD of size 15 cm and resistance 1.0 Ω is moved at a uniform velocity of v m/s, in a uniform magnetic field of 2 T, the field lines being normal to the plane of the paper. The loop is connected to an electrical network of resistors, each of 2 Ω. Find the speed of the loop, for which 2 mA current flows in the loop.



The circuit ABCD is forming a balanced Wheatstone bridge.

Now, resistance of the circuit,

$$\frac{1}{R} = \frac{1}{(2+2)} + \frac{1}{(2+2)} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

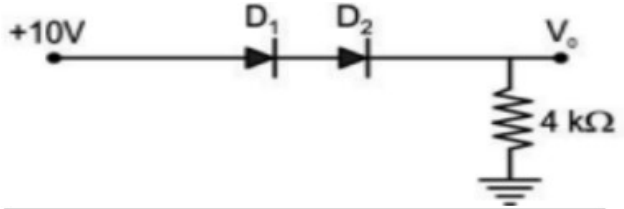
$R = 2\Omega$ and resistance of coil is 1Ω

$\therefore$ Net resistance, $R. = 2 + 1 = 3\Omega$

Motional emf, $\varepsilon = Blv$

$\therefore$ Current $I = \frac{\varepsilon}{R} = \frac{2 \times 0.15 \times 0.1}{3} = 0.01A$

19. The threshold voltage for diodes D_1 and D_2 are 0.3 V and 0.7 V respectively. Determine current in the circuit.Find V_0



$V_{D_1} = 0.3$ V $\quad V_{D_2} = 0.7$ V

So $V_o = 10 - 0.3 - 0.7 = 9$ V

So $10 - V_{D_1} - V_{D_2} = V_o$

$I_D = V_o/R = 9/(4 \times 10^{-3}) = 2.25$ mA

Or

Calculate the orbital period of the electron in the first excited state of hydrogen atom.

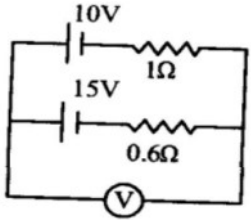
20 .Violet light is incident on a converging lens of focal length f.State with reason, how the focal length of the lens will change, if the violet light is replaced by red light.

We know $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ $f \propto \frac{1}{(\mu-1)}$ and $\mu_v > \mu_R$

The increase in refractive index would result in decrease of focal length of lens.

Hence, we can say by replacing red light with violet light, decreases the focal length of the lens used.

21. A 10 V battery with internal resistance 1Ω and a 15V battery with internal resistance 0.6Ω are connected in parallel to a voltmeter as shown in the figure. The reading in the voltmeter will be close to



As the two cells oppose each other hence,

the effective emf in closed circuit is $15-10=5V$

and net resistance is $1+0.6=1.6\,\Omega$

Current in the circuit, $\frac{\text{effective emf}}{\text{total resistance}}=\frac{5}{1.6}A$

The potential difference across voltmeter will be same as the terminal voltage of either cell. Since the current is drawn from the cell of $15\,V$

$\therefore V_1=E_1-Ir_1=15-\frac{5}{1.6}\times 0.6=13.1\,V$

SECTION - C [Each question carries 3 mark]

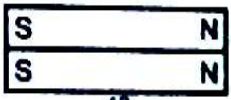
22. (a) Calculate the force per unit length acting between two parallel wires of infinite extent separated by a distance 2 cm each carrying current of 4 A .

$$F_l = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d}$$

When $I_1 = I_2 = 4A$ $d = 2\text{ cm} = 2 \times 10^{-2}$ m

$$F_l = \frac{\mu_0}{4\pi}\frac{2I_1 I_2}{d} = 10^{-7} \times \frac{2 \times 4 \times 4}{2 \times 10^{-2}} = 16 \times 10^{-5}\ \text{Nm}^{-1}$$

(b) Two identical bar magnets of magnetic dipole moment M each are arranged as shown in the figure (i) and figure (ii).



(i)

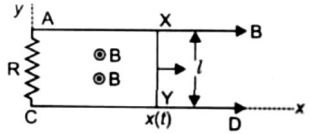
(ii)

What will be the dipole moment in each case?

In fig(i) Dipole moment = 2M x L = 2ML

In fig(iI) Dipole moment = M x 2L = 2ML

23. A conducting wire XY of mass m and negligible resistance slides smoothly on two parallel conducting wires as shown in figure. The circuit has a resistance R due to AC. AB and CD are perfect conductors. There is a magnetic field B =B(t) $\hat{k}$



(a) Write down equation for emf induced in the wire XY.

(b) Find the current flowing through R .

(i) Let the wire be at $x = x\,(t)$ at time t.

Flux $= B\,(t)\; l\, x\,(t)$

$$E = -\frac{d\phi}{dt} = -\frac{dB(t)}{dt} l x(t) - B(t) l.v(t)$$

(ii) the current flowing through R .

$$I = \frac{E}{R} = -\frac{dB(t)}{R\,dt} l x(t) - B(t) l.v(t)$$

24. The primary coil of an ideal step-up transformer has 100 turns and the transformation ratio is also 100. The input voltage and power are 220 V and 1100 W respectively. Calculate

(a) number of turns in the secondary coil

(b) the current in the primary coil and secondary coil

(c) voltage across the secondary coil

(d) power in the secondary coil

Given , $N_1 = 100$, $k = 100$, $V_1 = 220V$, $P_1 = 1100W$

(a) As, $k = \dfrac{N_2}{N_1}$ $\quad N_2 = kN_1 = 100 \times 100 = 10000$

(b) $P_1 = V_1 I_1 \Rightarrow I_1 = \dfrac{P_1}{V_1} = \dfrac{1100}{220} = 5A$

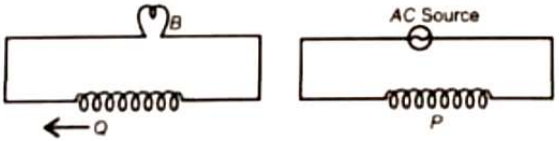
$\dfrac{I_1}{I_2} = k \Rightarrow I_2 = \dfrac{I_1}{k} = \dfrac{5}{100} = 0.05\ A$

(c) $\dfrac{V_2}{V_1} = k \Rightarrow V_2 = kV_1;\ V_2 = 100 \times 220 = 22000$

(d) $P_2 = V_2 I_2 \Rightarrow P_2 = 22000 \times \dfrac{5}{100};\ P_2 = 1100\ W$

Or

A coil Q is connected to low voltage bulb B and placed near another coil P as shown below . Give reasons to explain the following observations:



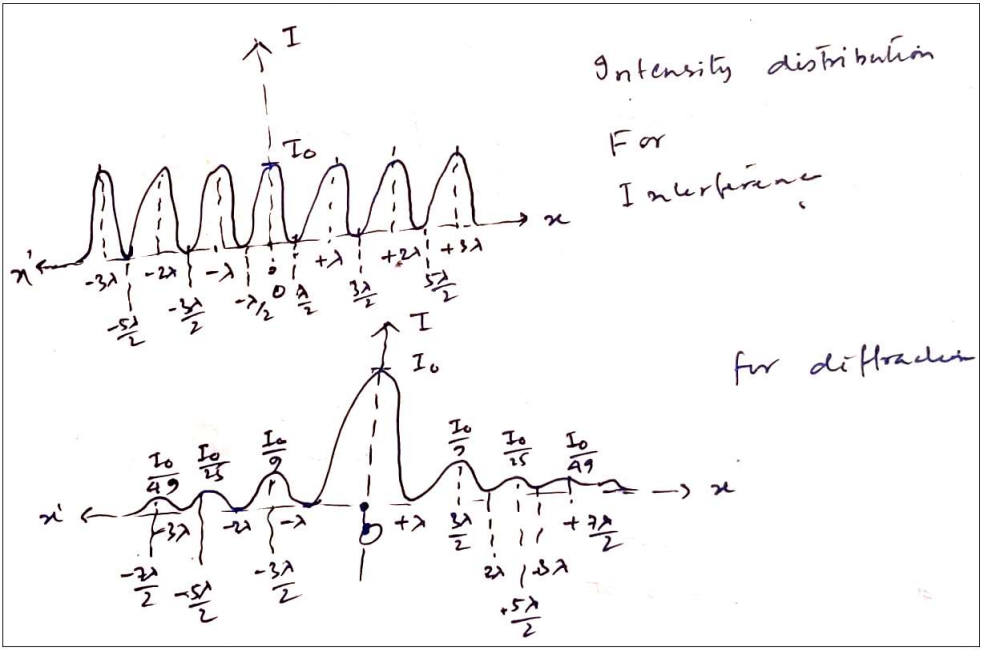
(a) The bulb B lights

(b) Bulb gets dimmer if the coil Q is moved towards left.

(a) The bulb B lights due to induced current in coil Q because of change in magnetic flux linked with it on a consequence of continuous variation of magnitude of alternating current flowing in P.

(b) When coil Q moves towards left the rate of change of magnetic flux linked with Q decreases and so lesser current is induced in Q.

25. (a) Draw the intensity pattern for single slit diffraction and double slit interference.

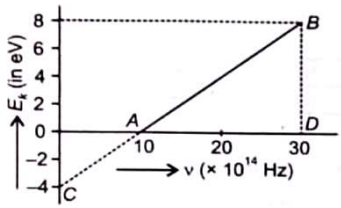


(b) State two differences between interference and diffraction patterns.

Difference :

(i) Interference fringes are of same intensity whereas diffraction fringes are of different intensity.

26. (a) Given below is the graph between frequency (ν) of the incident light and maximum kinetic energy (E_k) of emitted photoelectrons. Find the values of (i) threshold frequency and (ii) work function from the graph.



(i) Threshold frequency ,

$v_0 = 10 \times 10^{14} Hz = 10^{15} Hz$

(ii) At, $v = 0, E_k = h \times 0 - \phi_0 = -\phi_0$

or $\phi_0 = -E_k = -(-4eV) = 4eV$

(b) In photoelectric effect, why should the photoelectric current increases as the intensity of monochromatic radiation incident on a photosensitive surface is increased? Explain.

Increase in intensity of incident radiation corresponds to an increase in the number of incident photons, resulting an increase in the number of photo electrons emitted.

27. (a) Using postulates of Bohr's theory of hydrogen atom, show that

(i) the radii of orbits increase as n^2 , and

(ii) the total energy of the electron increases as l/n^2 , where n is the principal quantum number of the atom.

(b) Calculate the wavelength of H_α line in Balmer series of hydrogen atom, given Rydberg's constant R = 1.0947×10^7 m^{-1}.

H_α line is first line of Balmer series for which n=3

$$\lambda = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R \times \frac{5}{36}$$

$$\lambda = \frac{36}{5R} = \frac{36}{5 \times 1.1 \times 10^7} m = 6.545 \times 10^{-7} m$$

28. Answer the following.

(a) Why do Ge and Si behave as semiconductors?

(b) Draw IV characteristics of PN junction diode .

(c) What is meant by doping in semiconductor?

SECTION - D[Each question carries 4 marks]

Case Study Based Questions

29.Read the following paragraph & answer the questions that follow

Refraction of light is change in the direction of propagation of light when it enters into the Other medium. is refractive index of second medium with respect to medium l. The refracted ray deviate towards the normal or away from normal depending on the density of medium also known optical density. Optical density should not be confused with mass density. Refraction is responsible for many interesting phenomena in atmosphere.

(i) When a ray of light enters from one medium to another, then which of the following remains unchanged?

(a) wavelength (b) speed
(c) amplitude (d) frequency

Ans - (d)

(ii) Refractive index of a transparent medium is greater than one because

(a) speed of light in vacuum is always less than speed in a transparent medium.

(b) speed of light in vacuum is always greater than the speed in a transparent medium.

(c) frequency of wave changes when it crosses medium.

(d) none of these.

Ans - (c)

(iii) A setting sun appears to at an altitude higher than it really is. This is because of

(a) absorption of light. (b) reflection of light.

(c) refraction of light. (d) dispersion of light.

(iv) The time taken by the light to cross a glass of thickness 4 mm and refractive index ($\mu = 3$). will be

(a) 4×10^{-11} s (c) 40×10^{-11} s

(b) 0.4×10^{-11} s (d) 0.04×10^{-11} s

$$\text{Time, } t = \frac{\text{Thickness of glass}}{\text{Speed of light in glass}}$$

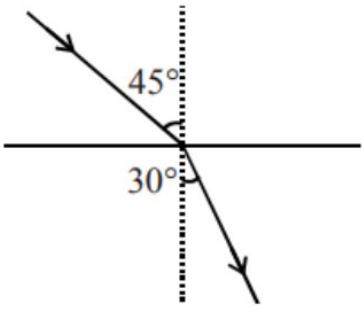
$$\frac{d}{c/a} = \frac{\mu d}{c} = \frac{3 \times 4 \times 10^{-3}}{3 \times 10^{8}} = 4 \times 10^{-11}\ \text{s}$$

Or

(iv) A ray of light is incident on the surface of separation of a medium with the velocity of light at an angle 45^0 and is refracted in the medium at an angle 300. What will velocity of light in the medium?

(a) 1.96 X 10^8 m/s (b) 3.18 x 10^8 m/s

(c) 2.12 x 10^8 m/s (d) 3.33 x 10^8 m/s



Refractive index,

$$\mu = \frac{\sin 45^\circ}{\sin 30^\circ}$$

$$= \frac{1}{\sqrt{2}} \times 2$$

$$\mu = \sqrt{2}$$

$$\text{Now, } \mu = \frac{\text{Velocity of light in air}}{\text{Velocity of light in medium}} = \sqrt{2}$$

Velocity of light in medium

$$= 3 \times 10^8 \times \frac{1}{\sqrt{2}} = 2.12 \times 10^8 \text{ m/sec}$$

30.Read the following paragraph and answer the questions that follow

The bands namely valence band and conduction band which are generated by the interaction of atoms. The conduction band at temperature is always empty and valence band is 'filled. There exists a band gap between the two bands. The band gap > 3 eV is insulator. E_g between 0.2 eV and 3 eV is semiconductor but for metal $E_g = 0$ i.e., no

gap between bands is seen and that's why they are called goodconductors.By doping we can change the characteristic of the elements

(i) An intrinsic semiconductor is converted into n-type extrinsic semiconductor by doping it with

(a) germanium (b) phosphorus

(c) aluminium (d) silver

Ans - (b)

(ii) In an n-type semiconductor, which of following statements is true?

(a) Electrons are majority carriers and trivalent atoms are dopants.

(b) Electrons are minority carriers and pentavalent atoms are dopants.

(c) Holes are minority carriers and pentavalent atoms are dopants.

(d) Holes are majority carriers and trivalent atoms are dopants.

Ans - (c)

(iii) For a p-type semiconductor, which of following statements is true?

(a) Holes are the majority carriers and trivalent atoms are dopants.

(b) Holes are the majority carriers and Ixntavalent atoms are dopants.

(c) Electrons are the majority carriers and pentavalent atoms are dopants.

(d) Electrons are the majority carriers and trivalent atoms are dopants.

Ans-(b)

(iv) In semiconductors at a room temperature

(a) the valence band is partially empty and the conduction band is partially filled.

(b) the valence band is completely filled and conduction band is partially filled.

(c) the valence band is completely filled.

(d) the conduction band is completely empty.

Ans -(d)

Or

(iv) At zero. Ge acts as

(a) non-metal (b) metal

(c) insulator (d) semiconductor

Ans-(c)

SECTION - E [Each question carries 5 marks]

31.(a) Define the term 'electrostatic potential'. Find an expression for the electrostatic potential due to an electric dipole at a point .

(b)Explain why electrostatic potential inside a charged hollow sphere is zero .

Or

Define the capacitance of a capacitor. Obtain the expression for the capacitance of a parallel plate capacitor in vacuum in terms of plate area A and separation d between the plates d .

What will be the expression for the capacitance of the parallel plate capacitor if a dielectric slab of thickness t (t < d) is introduced between the plates of capacitor.

P and Q are two parallel plates. The distance between them is d.

A dielectric material of thickness t(t < d) and dielectric constant K is inserted in between the plates.

In the remaining space (d - t) there is air.

The electric field in the dielectric-filled portion = $E_1 = \frac{\sigma}{\varepsilon_0 K}$

The electric field in the air-filled portion = $E_2 = \frac{\sigma}{\varepsilon_0}$

The potential difference between the plates = V

$$V = E_2 \times (d - t) + E_1 \times t$$

$$\text{Or, } V = \frac{\sigma}{2\varepsilon_0} \times (d - t) + \frac{\sigma}{\varepsilon_0 K} \times t$$

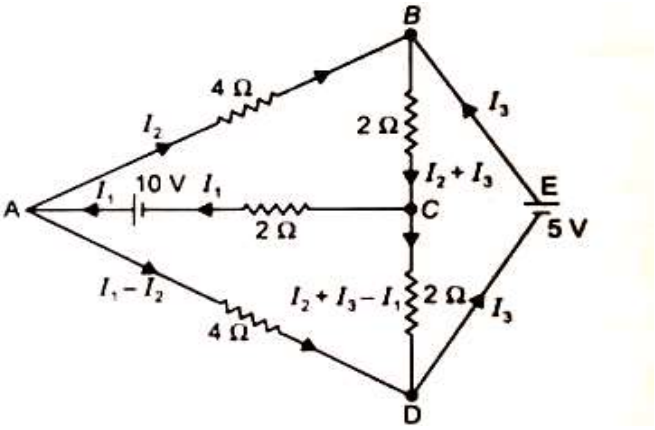
$$\text{Or, } V = \frac{q}{A\varepsilon_0} \times \left[(d - t) + \frac{t}{K}\right]$$

$$\text{Now, capacitance} = C = \frac{q}{V}$$

$$\text{Or, } C = \frac{\varepsilon_0 A}{(d - t) + \frac{t}{K}}$$

32. (a) State Kirchhoff's rules for electrical circuits with diagrams.

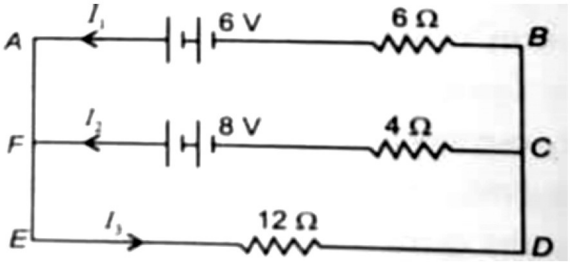
(b)Determine the current in each branch of the network shown below



NCERT EXAMPLE 3.7 PAGE NO 117

Or

In the network shown here, find the following:



(a) Currents I_1, I_2 and I_3

(b) Terminal potential difference of each battery.

Consider 6 Ω to be the internal resistance of 6 V battery and 4 Ω to be internal resistance of 8 V battery.

33.(a) Draw a ray diagram of compound microscope. Write the expression for its magnifying power.

(b) A compound microscope consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 18 cm. How far from the objective lens should an object be placed in order to obtain the final image at the least distance of distinct vision (25 cm)? Find the magnifying power of the microscope.

$f_0 = 2$ cm, $f_e = 6.25$cm. $v_e = -25$ cm, $u_e = ?$

(a) $\frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = \frac{1}{-25} - \frac{1}{6.25} = \frac{-1-4}{25} = \frac{-5}{25}$, $u_e = \frac{-25}{5} = -5$ cm.

$v_0 = 18 - 5 = 13$ cm.

$\frac{1}{u_0} = \frac{1}{v_0} - \frac{1}{f_0} = \frac{1}{13} - \frac{1}{2} = \frac{2-13}{26} = \frac{-11}{26}$ $\quad u_0 = \frac{-26}{11} = 2.36$ cm.

magnifying power $m = \frac{v_0}{|u_0|}\left(1 + \frac{d}{f_e}\right) = \frac{10}{2.36}\left(1 + \frac{25}{6.25}\right) = 21.18$

Or

(a) Obtain the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for the fringe width.

(b)What are the criteria for obtaining interference fringes on a seen ?

(c) Is the phenomenon of interference of light in accordance with the law of conservation of energy? Justify.