2012

Part: I

Question: 1

Answer all questions

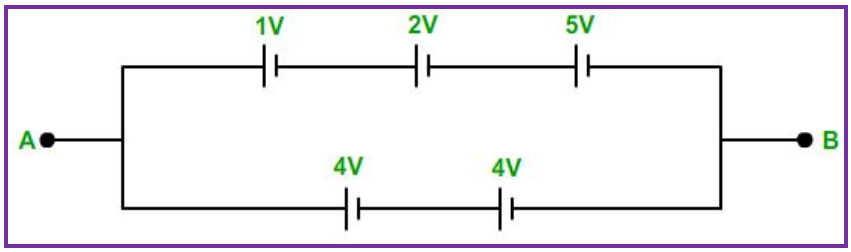
1. Choose the correct alternatives A,B, C or D for each of the questions given below: [5]

a. A body has a positive charge of 8x 10-19C. It has:

- O an excess of 5 electrons
- O a deficiency of 5 electrons
- O an excess of 8 electrons
- O a deficiency of 8 electrons

Answer:

b. Figure 1 below shows five dc sources (cells). Their emfs are shown in the figure. [5]

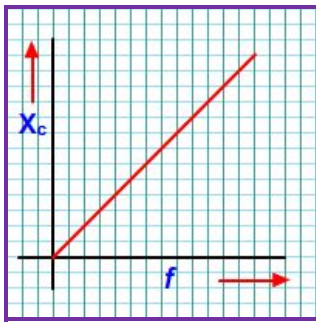


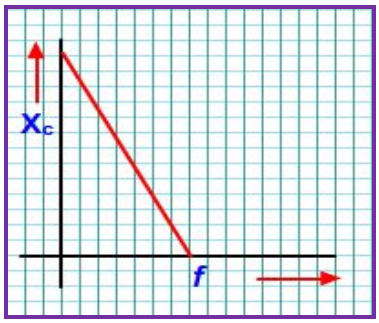
Emf of the battery AB is:

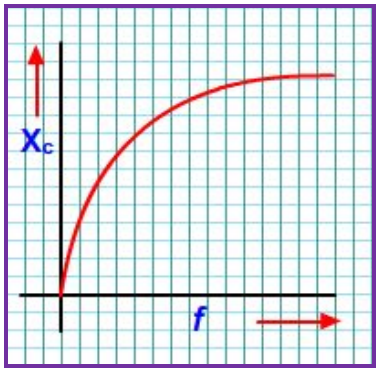
- O 8V
- O 16V
- O 4V
- O 2V

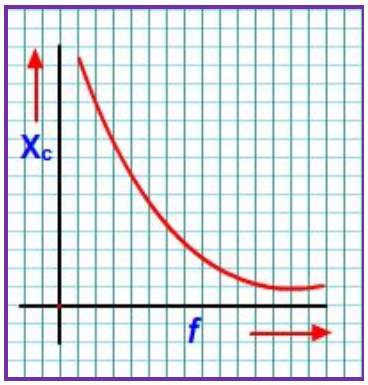
Answer:

c. Which one of the following graphs in Figure 2 represents variation of resistance 'X_c' [5]

O 

o 

o 

o 

Answer:

d. White light is passed through sodium vapours contained in a thin walled glass flask and the transmitted light is examined with the help of a spectrometer. The spectrum so obtained is:

- o Absorption spectrum
- o Solar spectrum
- o Band spectrum
- o Continuous spectrum

Answer:

e. Binding energy of a nucleus is of the order of:

- Electron Volt (eV)
- Kilo electron volt (KeV)
- Mega electron volt (MeV)
- a joule (J)

Answer:

2. Answer all questions briefly and to the point: [15]

i. Identify the nuclides X and Y in the nuclear reaction:

ii. $_5B^{11} + {}_1H^1 \rightarrow {}_4Be^8 + X$

iii. $_6C^{14} \rightarrow Y + {}_{-1}e^0$

Answer:
See topics on 'Nuclear fission'.

ii. Which conservation principle is involved in Kirchoff's first law of electric circuits?

Answer:
See topics on 'Kirchoff's law'.

iii. Write an expression of magnetic flux density 'B" at a point in end- on position of an axial position of a magnetic dipole. (Derivation not required.)

Answer:
See topics on 'Definition of $\vec{B}$'.

iv. In a moving coil galvanometer, what is meant by a radial magnetic field?

Answer:
See topics on 'moving coil galvanometer'.

v. Write down the lens maker's formula, using standard symbols.

Answer:
See topics on 'Lens'.

vi. Which electromagnetic radiation has wavelength greater than that of X rays and smaller than that of visible light?

Answer:
Gamma rays

vii. How did Fresnel construct a biprism in order to study interference of light?

Answer:
See topics on 'Fresnel principle'.

viii. State Brewster's law of polarization of light.

Answer:
See topics on 'Brewster's law'.

i. What are energy bands in solids?

Answer:
See topics on 'Energy bands'.

ix. What condition must be satisfied by two thin lenses kept in contact so that they form an acromatic doublet, i.e., a combination free from chromatic aberration?

Answer:
The most common type of achromat is the achromatic doublet, which is composed of two individual lenses made from glasses with different amounts of dispersion.

Usually one element is a concave lens made out of flint glass, which has relatively high dispersion, while the other, convex, element is made of crown glass, which has lower dispersion.

The lens elements are mounted next to each other, typically cemented together, and shaped so that the chromatic aberration of one is counterbalanced by the chromatic aberration of the other.

x. What conclusion was drawn by Rutherford based on Geiger-Marsden's experiment on scattering of alpha particles?

Answer:
See topics on 'Rutherford's experiment'.

xi. What is meant by half life of a radioactive substance?

Answer:
See topics on 'half-life'.

xii. What is the essential difference between the working of a nuclear reactor and that of a fission bomb?

Answer:
See topics on 'nuclear reactor'.

xiii. State one important use of a Zener diode.

Answer:
See topics on 'zener'.

Part: II

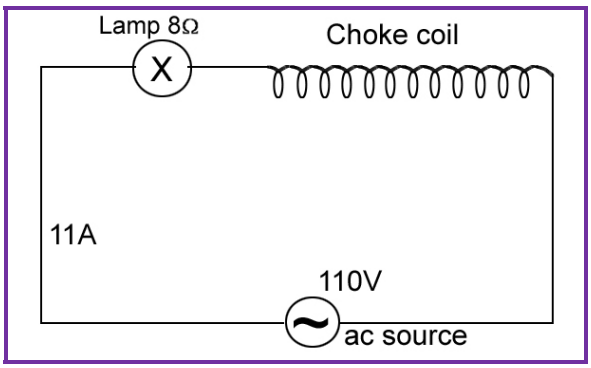
Answer six questions in this part, choosing two questions from each of the Sections A, B and C

Section: A

Answer any two questions

Question: 2

i. State Biot – Savart law. Write an expression for the magnitude of the magnetic field at the centre of a circular coil of N turns. What is meant by time constant of a circuit with a resistor and an inductor connected in series? [4]



Answer:
See topics on 'Biot – Savart's law'.

ii. What is the purpose of concave pole pieces in a moving coil galvanometer? Draw labelled diagrams to illustrate conversion of a galvanometer into - [3]
i. Ammeter

Answer:
See topics on 'Ammeter'.

ii. Voltmeter. [3]

Answer:
See topics on 'Using galvanometer'.

iii. A lamp with a resistance of 8Ω, is connected to a choke coil as shown in figure. This arrangement is connected to an alternating source of 110 volt. The current in the circuit is 11A. The frequency of the AC is 60 Hz. Find i) impedance of the circuit and ii) value of inductive reactance of the choke coil. [2]

Answer:
The applied emf: 110 volt
The current in the circuit: 11 ampere

The impedence of the circuit

$Z = \frac{E}{i} = \frac{110}{11}$ = 10 ohm

Inductive Reactance (X_L)

Since, $Z = \sqrt{R^2 + XL^2}$

or, $Z^2 = R^2 + X_L^2$

The inductance of the choke coil will be

$\Rightarrow X_L = \sqrt{Z^2 - R^2}$

$= \sqrt{10^2 - 8^2}$

$= \sqrt{100 - 64}$

$= \sqrt{36}$

= 6 ohm

Since,

$X_L = \omega L$

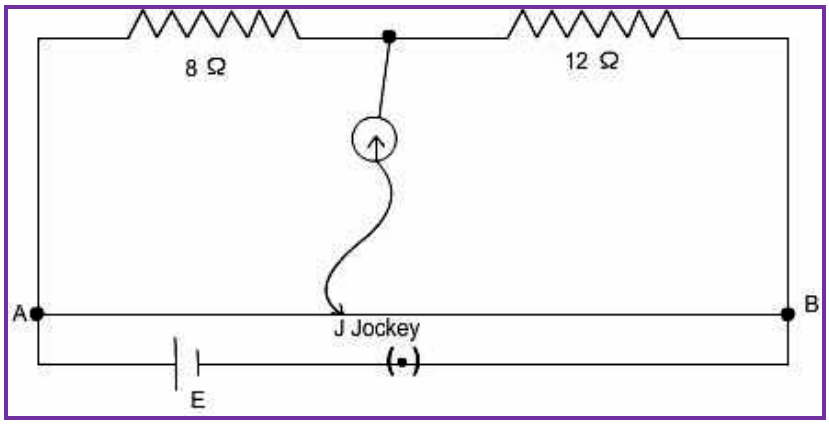
$L = \frac{X_L}{\omega} = \frac{X_L}{2\pi f}$

$= \frac{6}{2 \times 3.14 \times 60}$

= 0.016 henry

Question: 3

a.



In the above circuit diagram, the length of the wire AB = 400 cm. Where should the jockey, J be placed so that the galvanometer shows a zero deflection? [4]

Answer:

$\frac{R_1}{R_2} = \frac{l_1}{l_2}$

$\frac{8}{12} = \frac{l_1}{400 - l}$

$3200 - 8\, l_1 = 12\, l_1$

$20l1 = 3200$

l_1 = 160 cm from A

i. With the help of a neatly drawn and labeled diagram, obtain balancing condition of a Wheatstone bridge. [3]

Answer:

See topics on 'Wheatstone bridge'.

ii. State any two differences between Peltier effect and Joule effect. [2]

Answer:
See topics on 'Difference between C effect / joules effect'.

Question: 4

i. A wire of length 10 cm, carrying 10 amp of current is placed at an angle of 53^0 with respect to a magnetic field $\vec{B}$ of strength 0.1 tesla. Find the force experienced by the wire $\left[\text{use } \sin 53^0 = \frac{4}{5}\right]$ [9]

Answer:
The direction of current at the cold junction of a thermocouple thermometer, in which iron and copper is being used is Cu to Fe.

ii. Draw a simple ray diagram showing the formation of a primary rainbow. [2]

Answer:
See topics on 'Rainbow formation'.

Answer:

iii. What the four different types of energy losses in a transformer? State how to reduce/minimize any one of them.

Answer:
See topics on 'Losses'.

Section: B

Question: 5

a. On the basis of Huygen's wave theory, prove Snell's law of refraction of light. Draw a neat and labeled diagram. (Postulates of Huygen's wave theory not required). [4]

Answer:
See topics on 'Huygens' principle'.

b. In Young's double slit experiment using monochromatic light of wave-length 600 nm , interference pattern was obtained on a screen kept 1-5m away from the plane of the two slits. Calculate the distance between the two slits , if firing separation /fringe width was found to be 1-0 nm. [2]

Answer:
See topics on 'Double slit'.

c. Draw a labelled graph to show variation in intensity of diffracted light with angular position, in a single slit diffraction experiment. [2]

Answer:
See topics on 'Single slit'.

Question: 6

a. An electron beam passes through crossed electric and magnetic fields of 3.4 x10^4 Vm^{-1} and 2X 10^{-3} Wbm^{-2} respectively. If the path of the beam remains un-deviated, calculate the speed of the electrons. [3]

Answer:

Given,

E = 3.4 x 10^4 V/m

B = 2 x 10-3 Wb/m^2

We know, $v = \frac{E}{B} = \frac{3.4 \times 10^4}{2 \times 10^{-3}}$

Radius of circular path described by the electrons is given by, $r = \frac{mv}{eB}$

Given, mass of electron: 9.1 x 10-31 kg

Charge of electron: 1.6 x 10-19 C

So, $r = \frac{9.1 \times 10^{-31} \times 1.70 \times 10^7}{1.6 \times 10^{-19} \times 2 \times 10^{-3}}$

b. For any prism, Show that refractive index of its material is given by :

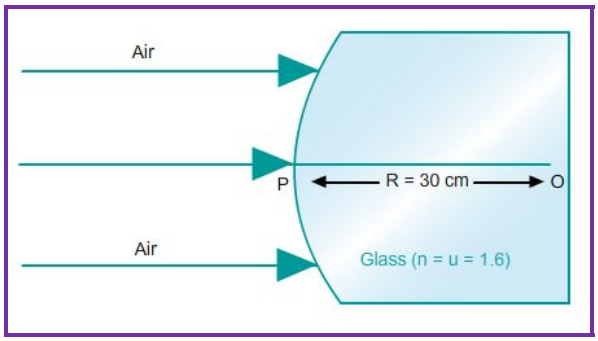
$$n \text{ or } \mu = \frac{\text{Sin}\left(\frac{A + \partial m}{2}\right)}{\text{Sin}\left(\frac{A}{2}\right)}$$

Where the terms have their usual meaning.

Answer:

See topics on 'Prism'.

c. Figure 6 below shows a parallel beam of monochromatic light incident on a convex spherical surface, radius of curvature R = 30 cm, which separates glass (refractive index = 1.6) from air. Find the position of the image formed due to refraction of light at this single spherical surface. [2]



Answer:

Question: 7

i. What is meant by [3]

a. Spherical aberration?

Answer:
See topics on 'Spherical'.

b. Chromatic aberration?

Answer:
See topics on 'Chromatic'.

ii. How can spherical aberration be reduced / minimized? Suggest any one method. [3]

Answer:
See topics on 'Removal'.

a. Explain why the electrical conductivity of a pure semi – conductor increases on heating.

Answer:
If a pure semi-conductor is heated, the increase in temperature makes the electrons move from valence band to conduction band. Thus more free electrons are available for the conduction of electricity.

Furthermore, due to increase in temperature more covalent bonds break.

iii. [2]

a. Define Resolving Power of a simple astronomical telescope.

Answer:
See topics on 'Resolving power'.

b. State one advantage of a reflecting telescope over refracting telescope.

Answer:
See topics on 'Reflecting'.

Section: C

Question: 8

i. Draw a simple ray diagram showing the formation of a primary rainbow. [2]

Answer:
See topics on 'Rainbow formation'.

ii. Using Huygens's principle, prove the laws of refraction of light [3]

Answer:
See topics on 'Huygens' principle'.

iii. A 900 pF capacitor is charged by a 100 V battery. How much energy is stored by the capacitor?

Answer:
Capacity of the capacitor,
C = 900 pf
= 900 x 10-12 f
Charging potential, V = 100 volt
Energy stored in the capacitor

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

$$= \frac{1}{2} \times \left(900 \times 10^{-12}\right) \times (100)^2$$

= 4.5 x 10-6 Joules

Voltage across primary = 200 volt
Voltage across secondary = 2000 volt
Current in primary coil = Voltage across secondary coil
Current in seconday coil = voltage across primary coil

$$\frac{i_p}{i_s} = \frac{V_s}{V_p} = \frac{2000}{200} = 10$$

Question: 9

i.
b. What is Compton effect? [3]

Answer:
See topics on 'Compton scattering'.

ii. In Coolidge X – Ray tube (Modern X-Ray tube) how will you vary

a. Intensity of emitted X-Rays?

Answer:
See topics on 'X-rays'.

b. Penetrating power of emitted X-Rays?

Answer:
See topics on 'X-rays'.

c. The emf 'E' of a thermocouple varies with the temperature θ (in degree C)of the hot junction (cold junction at 0^0C) as $E=15\ \theta - 0.05\ \theta^2$.Determine the neutral temperature. [2]

Answer:
Given, $E = 15\ \theta - 0.05\ \theta^2$.
Differentiating E w.r.t. θ

$\frac{dE}{d\theta} = 15 - 2 \times 0.05\theta$

$\frac{dE}{d\theta} = 15 - 0.1\theta$

At neutral temperature, $\theta = \theta_n$ and $\frac{dE}{d\theta} = 0$

$0 = 15 - 0.1\ \theta_n$

So, $0.1\ \theta_n = 15$

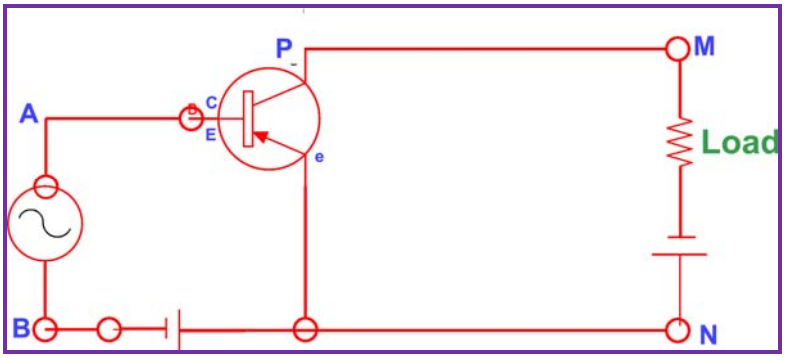
$\theta_n = \frac{15}{0.1} = 150^0C$

Question: 10

i. Draw a labeled energy band diagram for a solid which is an insulator. What is the main difference between this diagram and that of a semi - conductor? [3]

Answer:
See topics on 'Energy bands'.

ii. The figure below shows the circuit of an electronic device : [3]



a. Which electronic device: a rectifier, an amplifier or an oscillator does the above circuit represent?

Answer:
An amplifier

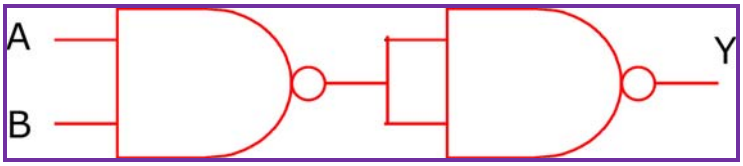
b. State where the input voltage is applied and where the output voltage is available.

Answer:
See topics on 'Common emitter amplifier'.

c. Compare the output voltage of this circuit with its input voltage.

Answer:
See topics on 'Common emitter amplifier'.

iii. Prepare a truth table for the combination of gates shown in the figure below. [2]



Some useful constants and relations:

1.	Speed of light in Vacuum	c	3.0 X 10^{8} ms^{-1}
2.	Planck's Constant	h	6.6 X 10^{-34} Js
3.	Charge of an electron	-e	- 1.6 X 10^{-19} C
4.	Mass of an electron	m_e	9 X 10^{9} ms $^{-31\ kg}$
5.	Constant of proportionality	$\left(\frac{1}{4\pi\in_0}\right)$	9 X 10^{9} mF^{-1}
For Coulomb's Law			
6.	Electron Volt	1eV	1.6 X 10^{-19} J
7.	Unified Atomic Mass Unit	1u π 1nm	931 MeV 3.14 10^{-9} m

Answer:
See topics on 'Logic gates'.

(**) Currently out of syllabus. Answer can be provided up on request.