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WITH
TIME MANAGEMENT CHART
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2021 TOPPER TIP'S

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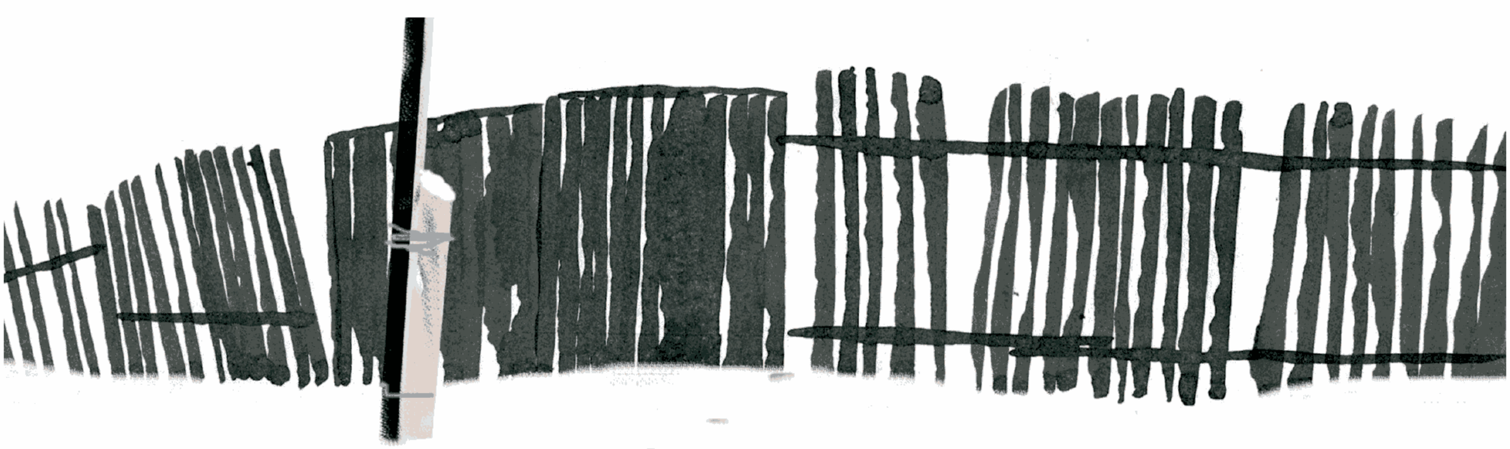


Hello!

Friends, this year is all about keeping caution, strengthening determination and smart learning. CBSE has made sweeping changes in the paper pattern of all subjects and we at Educart have adhered 100% to those changes.

After the record breaking sales and acceptance of our sample papers last year pan-india, we have launched class 12 books with some critical value additions. This is our special self-prep version for 2021 with the new objective section included.

EduCart has also roped in CBSE Physics experts and most experienced teachers, to analyse the new pattern and prepare a fine XIIth Class Physics Sample Papers Book for 2021.

Go break a leg!

Reviews

★★★★★ Read carefully what I am writing

By Sathya Raji on 2 October, 2020

Guys, this is a very emotional review who has gone through a lot. I lost confidence because of the lack of interest in studies. Dad said focus only on studies but I only like TikTok and PUBG. Now both got banned and I had no other option but to study effectively as mid-terms were near. Now 4 months has passed and I had no preparation of boards at all. So I decided to change things and bought EDUCART.

Their maps (mind maps rather) for the first time in life helped me understand that what all comes in the chapters & what's important in those chapters. I was actually being able to study. I mean how can someone put so much effort in writing the book. So that definately helped me figure some topics well. Today, I finished 2 chapters of chemistry from Educart book and managed to make my father proud.

★★★★★ Worth for 💰

By Malika on 3 September, 2020

It's a very good book for the candidates appearing in 2021.... very nice explanation and also very nice editing 👍👍 Go for itt!!!!!!

★★★★★ Wonderful book 😊

By S S on 10 September, 2020

Every paper has CBSE questions written in neat way with explanations and related theory. My father purchased this book for me as i m weak in science but i am so happy with it that im posting the review myself to thank educart personally. Edcart, please continue to make such books, in this covid time, this book is what we needed reallly!

T S Sudhir

(Author of Saina Nehwal's Biography | Journalist | Educator)

To: quickreply@agpgroup.in

Educart Exemplar is my suggested book for this year and I rarely recommend books. This one I have thoroughly read and liked for my students.

5★ Great product

Student

I recommend this book..... magnificent book for revision...so many good questions are there... My God! the mind maps are super cool... A must buy book ...for class 10 students...just a little mistakes are there but it doesn't matter as those are check points of your learning Mustbuy 👍👍👍👍👍

Dear Sir

6.77M Subscribers

India ki pehli atma-nirbhar self prep book that really no publisher can match with. Educart question bank is a must buy for all students!

RC Chauhan

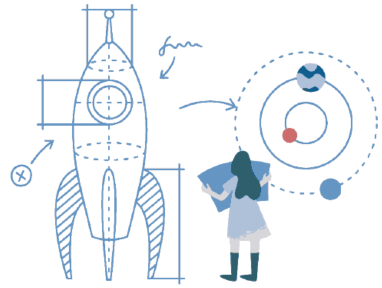
HOD of Mathematics - DPS

To: quickreply@agpgroup.in

We have reviewed countless Xth Class Maths books but Educart's Sample papers is our top recommendation. Educart has done their homework well on how CBSE students nowadays want to learn solving of maths standard questions.

Contents

** Self-assessment papers' solution are available on our website (www.educart.net).*



Question Paper Design

Sections ↓	← TYPOLOGY OF QUESTIONS →						
	VSA	Assertion Reason	Case-based	SA I	SA II	LA	
	1m each	*1m each*	*4m each*	*2m each*	*3m each*	*5m each*	
Section A	10Q (4 choice)	4Q	–	–	–	–	**14m**
Section B	–	–	2Q (5 MCQ and 1 choice per Q)	–		–	**8m**
Section C	–	–	–	9Q (3 choice)	–	–	**18m**
Section D	–	–	–	–	5Q (2 choice)	–	**15m**
Section E	–	–	–	–	–	3Q (3 choice)	**15m**
Total Marks	**10Q (10m)**	**4Q (4m)**	**2Q (8m)**	**9Q (18m)**	**5Q (15m)**	**3Q (15m)**	**70m**

Note: This blueprint is prepared for simplicity purpose, based on the CBSE Sample Paper provided on 9th October 2020.

Time Management

The 3 hour long board paper needs to be attempted strategically so that you are not cut short for time on any question at the end. This means you need to complete each section of the paper within a pre-defined duration. Our experts have figured out the optimum time duration for each section for you to keep in mind. Please see below the time management chart for all subjects:

PHYSICS				
Sections	**Question Type**	**Questions**	**Time To Be Spent (Per Question)**	**Total Time**
Section A	VSA	10Q (1m each)	2 min per question	(10 + 4) x 2 = 28 min **≃ 30 min**
	Assertion Reason	4Q (1m each)		
Section B	Case-based	2Q (8MCQ) (6m each)	10 min reading time + 2 min per question	(10 + 8) x 2 = 26 min **≃ 25 min**
Section C	SA I	9Q (2m each)	4 min per question	9 x 4 = 36 min **≃ 35 min**
Section D	SA II	5Q (3m each)	7 min per question	5 x 7 = **35 min**
Section E	LA	3Q (5m each)	12 min per question	3 x 12 = 36 min **≃ 35 min**
				Total Time: **2 hours 40 min**
				Revision Time: **20 min**

Topper Tips

(on cracking new pattern)

Friends, on request of the Educart team, followed below are some points I've prepared for you to keep in mind whilst attempting the Class 12 Board Exams on the new pattern:

Notes and Derivations driven practice

- This year the Physics objective section has various types of conceptual questions from Assertion Reason to VSA to Case Based MCQs. Make a complete list of derivations, formulae and experiments in your syllabus and keep that list handy. Mind Maps given in this book will help in that.
- While solving a derivation, try and comprehend the logic behind the derivations and revise the concepts regularly. If you do not like the numerical part, start early! Get used to the numerical part. A Physics paper without a numerical is like a comb without teeth.
- Do not forget to mention the S.I units (if any) of all physical entities.

Select your MCQ options wisely (Hindi and English Core)

50% paper is now MCQs based. Do not rush into choosing a particular option. If unable to find the answer; use the rule of elimination to reach the most appropriate answer. Usually ruling out other 3 options works out faster.

Cracking Case-based Questions

Here is the trick. CBSE cannot ask any MCQ in case-based questions that is going to take you more than 1-2 minutes to solve as it will be a 1m MCQ each. So don't worry about the length of the question, treat it like a normal value input or understanding or remembering based question and move ahead. Time is of the essence.

New Pattern MCQs (English)

CBSE has made a complete overhaul of MCQ's style of questioning in Reading and Literature comprehensions of English Section A. They are not direct but inference based and analytical thinking driven. Educart has provided detailed explanations in this book for such MCQs to help understand how to come to a conclusive option.

15 minutes reading time hack

- There is 30-50% internal choice this time in each section. You get good 15 minutes in the beginning to read the question paper. Use this time to mark the choice questions you are more confident in attempting to avoid wasting critical thinking time while writing the exam.
- Mark the tough questions you definitely don't know the answer to or where you feel you will struggle, and remember to leave space to come back to answering them.

Prioritise your Sections order

Decide which Section you would want to attempt first and which Section at last. Always attempt the easy questions first. This way your confidence will grow and you will be mentally ready to take on the more challenging questions.

Answers Structure has to be right

- Write most of the answers in bullet points (with headings) or in a tabular form where possible to save time and stick to the point. CBSE paper checkers prefer such format to make it easy to allot full marks.
- Underline key (value) points for all answers and follow word count to save on time.
- Explain lengthy answers with examples and diagrams.
- Recheck for all logics and calculations in case of numerical.

Syllabus

(Reduced)

Units	Unit Name	Marks
	Electrostatics	
I	Chapter–1: Electric Charges and Fields	
	Chapter–2: Electrostatic Potential and Capacitance	16
II	**Current Electricity**	
	Chapter–3: Current Electricity	
	Magnetic Effects of Current and Magnetism	
III	Chapter–4: Moving Charges and Magnetism	
	Chapter–5: Magnetism and Matter	
	Electromagnetic Induction and Alternating Currents	17
IV	Chapter–6: Electromagnetic Induction	
	Chapter–7: Alternating Current	
V	**Electromagnetic Waves**	
	Chapter–8: Electromagnetic Waves	
VI	**Optics**	18
	Chapter–9: Ray Optics and Optical Instruments	
	Chapter–10: Wave Optics	
VII	**Dual Nature of Radiation and Matter**	
	Chapter–11: Dual Nature of Radiation and Matter	
VIII	**Atoms and Nuclei**	12
	Chapter–12: Atoms	
	Chapter–13: Nuclei	
IX	**Electronic Devices**	
	Chapter–14: Semiconductor Electronics: Materials, Devices and Simple Circuits	7
	TOTAL	**70**
	Practicals (Experiments 16m + Practical 7m + Viva 7m)	**30**

Unit-I Electrostatics

Chapter–1: Electric Charges and Fields

Electric Charges; Conservation of charge, Coulomb's law-force between two-point charges, forces between multiple charges; superposition principle and continuous charge distribution.

Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, torque on a dipole in uniform electric field.

Electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet

Chapter–2: Electrostatic Potential and Capacitance

Electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges; equipotential surfaces, electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field.

Conductors and insulators, free charges and bound charges inside a conductor.

Dielectrics and electric polarisation, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor.

Unit-II Current Electricity

Chapter–3: Current Electricity

Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current; Ohm's law, electrical resistance, V-I characteristics (linear and non-linear), electrical energy and power, electrical resistivity and conductivity; temperature dependence of resistance.

Internal resistance of a cell, potential difference and emf of a cell, combination of cells in series and in parallel, Kirchhoff's laws and simple applications, Wheatstone bridge, metre bridge(qualitative ideas only)

Potentiometer - principle and its applications to measure potential difference and for comparing EMF of two cells; measurement of internal resistance of a cell(qualitative ideas only)

Unit-III Magnetic Effects of Current and Magnetism

Chapter–4: Moving Charges and Magnetism

Concept of magnetic field, Oersted's experiment.

Biot - Savart law and its application to current carrying circular loop.

Ampere's law and its applications to infinitely long straight wire. Straight and toroidal solenoids (only qualitative treatment), force on a moving charge in uniform magnetic and electric fields

Force on a current-carrying conductor in a uniform magnetic field, force between two parallel current-carrying conductors-definition of ampere, torque experienced by a current loop in uniform magnetic field; moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter.

Chapter–5: Magnetism and Matter

Current loop as a magnetic dipole and its magnetic dipole moment, magnetic dipole moment of a revolving electron, bar magnet as an equivalent solenoid, magnetic field lines; earth's magnetic field and magnetic elements.

Unit-IV Electromagnetic Induction and Alternating Currents

Chapter–6: Electromagnetic Induction

Electromagnetic induction; Faraday's laws, induced EMF and current; Lenz's Law, Eddy currents. Self and mutual induction.

Chapter–7: Alternating Current

Alternating currents, peak and RMS value of alternating current/voltage; reactance and impedance; LC oscillations (qualitative treatment only), LCR series circuit, resonance; power in AC circuits AC generator and transformer.

Unit-V Electromagnetic waves

Chapter–8: Electromagnetic Waves

Electromagnetic waves, their characteristics, their Transverse nature (qualitative ideas only).

Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.

Unit-VI Optics

Chapter–9: Ray Optics and Optical Instruments

Ray Optics: Refraction of light, total internal reflection and its applications, optical fibres, refraction at spherical surfaces, lenses, thin lens formula, lensmaker's formula, magnification, power of a lens, combination of thin lenses in contact, refraction of light through a prism.

Optical instruments: Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Chapter–10: Wave Optics

Wave optics: Wave front and Huygen's principle, reflection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light, diffraction due to a single slit, width of central maximum

Unit-VII Dual Nature of Radiation and Matter

Chapter–11: Dual Nature of Radiation and Matter

Dual nature of radiation, Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light.

Experimental study of photoelectric effect

Matter waves-wave nature of particles, de-Broglie relation

Unit-VIII Atoms and Nuclei

Chapter–12: Atoms

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum.

Chapter–13: Nuclei

Composition and size of nucleus

Nuclear force

Mass-energy relation, mass defect, nuclear fission, nuclear fusion.

Unit-IX Electronic Devices

Chapter–14: Semiconductor Electronics: Materials, Devices and Simple Circuits

Energy bands in conductors, semiconductors and insulators (qualitative ideas only) Semiconductor diode - I-V characteristics in forward and reverse bias, diode as a rectifier; Special purpose p-n junction diodes: LED, photodiode, solar cell.

Deleted

(For 2021 Exam)

Chapter-1 Electric charges and fields

Uniformly charged thin spherical shell (field inside and outside).

Chapter-3 Current Electricity

Carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors

Chapter-4 Moving Charges and Magnetism

Cyclotron

Chapter-5 Magnetism and Matter

Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis, torque on a magnetic dipole (bar magnet) in a uniform magnetic field;

Para-, dia- and ferro - magnetic substances, with examples. Electromagnets and factors affecting their strengths, permanent magnets..

Chapter-7 Alternating Current

Power factor, wattless current.

Chapter 8 Electromagnetic Waves

Basic idea of displacement current,

Chapter 9 Ray Optics and Optical Instruments

Reflection of light, spherical mirrors,(recapitulation) mirror formula, Scattering of light - blue colour of sky and reddish appearance of the sun at sunrise and sunset. Resolving power of microscope and astronomical telescope, polarisation, plane polarised light, Brewster's law, uses of plane polarised light and Polaroids.

Chapter-11 Dual Nature of radiation and matter

Davisson-Germer experiment

Chapter 13 Nuclei

Radioactivity, alpha, beta and gamma particles/rays and their properties; radioactive decay law, half life and mean life binding energy per nucleon and its variation with mass number

Chapter 14 Semiconductor Electronics: Materials, Devices and Simple Circuits

Zener diode and their characteristics, zener diode as a voltage regulator.

FAQs

1. Can we use black pen in CBSE board exam 2021?

As per last year's CBSE guideline, students appearing for CBSE Board Exams can write answers ONLY with a Blue color pen (blue or royal blue). It should be a ball point, gel or fountain pen.

If the students want to use a black pen to highlight or bold the points in answers or for writing titles or headlines then it is allowed.

2. Will the CBSE 2021 paper on reduced syllabus come based on the sample paper CBSE released? Will the difficulty level be the same?

Yes, it will be exactly as per the paper pattern and type of questions introduced by CBSE in the 9th October 2020 uploaded Sample paper. As far as the difficulty level is concerned, expect an easier paper than the provided sample paper as CBSE will not want to reduce chances of students to pass considering COVID-19 has made things a bit difficult. However, this Educart book is prepared keeping a medium difficulty level to prepare students fully for the upcoming new pattern paper.

3. When will CBSE provide datesheet for 2021 boards?

Exact dates for all subjects' exams is usually provided in the month of December of the ongoing academic session. Last year it came on 16th December 2019. Expect the same in the month of December and expect the exams start date to be later than March for the 2020-21 session.

4. How shall I prepare when there is not much time left?

When in shortage of time, less material to study from, is better. This can be done by focusing on only NCERT books (for theory) and our Educart sample papers for practice and nothing else. Educart Sample papers book is 100% designed on the upcoming 2021 paper to help you cover questions on all possible topics with detailed explanations.

5. What is the Pass Marks Cut-off and Criteria?

A candidate has to obtain a grade higher than E (i.e. atleast 33% marks) in all the five subjects of external examination in the main or at the compartmental examinations.

6. How do I access latest CBSE circulars and announcements?

You can always email us on quickreply@agpgroup.in for any update you want.
As far as official source is concerned, refer: www.cbseacademic.nic.in/circulars.html.

7. What is the process of applying for a recheck of Marks in a particular subject?

Any student has the right to do so within a week from date of declaration of CBSE board exam result.

The whole process of verification of marks is done online.Steps to apply for verification/rechecking of the answer sheet, are as follows: Apply for rechecking of marks on the CBSE's website www.cbse.nic.in by filling in your details and paying Rs. 500 per subject online (only). The result of verification of marks will be uploaded on the website automatically.

Overall, the verification will be restricted to checking whether all the answers have been checked, there has been no mistake in totalling of marks for each question and the marks have been transferred correctly on the title page of the answer book. A candidate may also apply for obtaining a copy of the evaluated answer book(s) at a later stage if not satisfied with the evaluation

8. What is the best way to practice from this book to score good marks?

In order to crack the board exam, this book is custom made to start with Topper Tips and Time management. This includes an explanation of how to smartly structure your 3 hours during the paper.

Once, you have covered the basics, you can go through the exclusive CBSE last year Topper hand-written solutions and CBSE papers to get a feel of what is normally asked and how to answer them.

Then you start with our most likely 6 solved sample papers, where you time yourself to complete each paper and cross-check your performance with our detailed solutions.

Lastly, the unsolved papers help you self-assess without the temptation of looking at the back and fine-tune your preparation. These are solid papers that, if done well will fully prepare you to do well in the 2021 board exam.

9. Who should I reach out to for any issue related to examination, re-evaluation of copy or any serious matter?

Ideally your only point of contact should be your school and they will take action on your behalf by submitting a request to CBSE regional office. However, we have managed to source some useful contacts in CBSE. Please refer to the next page for more information.

IMPORTANT CBSE CONTACTS

Lots of students and parents face the problem of not knowing how best to contact CBSE for matters related to *Examination, admission fees, last-minute change of subject, direct admissions, passing criteria, examination centre related issue, unfair means or even re-evaluation of results* if not satisfactory. This list is not exhaustive.

We have compiled a comprehensive list of contacts of your nearest CBSE Regional Offices for various issues depending on the region you belong to. CBSE prefers any request to be sent to Regional Offices only and that also via the head of your school ideally. It is, therefore, advised to make the request accordingly through a proper channel for prompt and timely action.

Your School Location/Region	CBSE Regional Office (RO) Contact Details
General	Dr. Sanyam Bhardwaj (Controller of Examinations) sanyamb.cbse@nic.in | 011-22515828 Dr. Joseph Emmanuel (Director (Academics) directoracad.cbse.nic.in | 011-23212603
Delhi, Foreign Schools	CBSE, PS-1-2, Institutional Area, I.P. Extn, Patparganj, Delhi - 110092 rodelhi.cbse@nic.in | 91-11-22239177-80, 22235948, 22235904
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1

CBSE
SAMPLE PAPER
9th October 2020

PHYSICS

Time Allowed: 3 Hours *Maximum Marks: 70*

General Instructions:

(i) All questions are compulsory. There are 33 questions in all.

(ii) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(iii) Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.

(iv) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

SECTION - A **14 marks**

All questions are compulsory. In case of internal choices, attempt any one of them:

1. Name the physical quantity having unit J/T. 1

2. Mention one use of part of electromagnetic spectrum to which a wavelength of 21 cm (emitted by hydrogen in interstellar space) belongs.

OR

Give the ratio of velocity of the two light waves of wavelengths 4000 Å and 8000 Å travelling in vacuum. 1

3. An electron with charge -e and mass m travels at a speed v in a plane perpendicular to a magnetic field of magnitude B. The electron follows a circular path of radius R. In a time, *t*, the electron travels halfway around the circle. What is the amount of work done by the magnetic field? 1

4. A solenoid with N loops of wire tightly wrapped around an iron-core is carrying an electric current I. If the current through this solenoid is reduced to half, then what change would you expect in inductance L of the solenoid.

OR

An alternating current from a source is given by $i = 10 \sin 314t$. What is the effective value of current and frequency of source? 1

5. What is the value of angular momentum of electron in the second orbit of Bohr's model of hydrogen atom? 1

6. In a photoelectric experiment, the potential required to stop the ejection of electrons from cathode is 4 V. What is the value of maximum kinetic energy of emitted Photoelectrons? 1

7. In decay of free neutron, name the elementary particle emitted along with proton and electron in nuclear reaction.

OR

In the following nuclear reaction, Identify unknown labelled X.

$^{22}_{11}Na + X \longrightarrow {}^{22}_{10}Ne + \nu_e$ 1

8. How does the width of a depletion region of a pn junction vary if doping concentration is increased?

OR

In half wave rectification, what is the output frequency if input frequency is 25 Hz? 1

9. When a voltage drop across a pn junction diode is increased from 0.70 V to 0.71 V, the change in the diode current is 10 mA. What is the dynamic resistance of diode? 1

10. Which specially fabricated p n junction diode is used for detecting light intensity? 1

For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

11. **Assertion (A):** In a non uniform electric field, a dipole will have translatory as well as rotatory motion.

Reason (R): In a non uniform electric field, a dipole experiences a force as well as torque. 1

12. **Assertion (A):** Electric field is always normal to equipotential surfaces and along the direction of decreasing order of potential.

Reason (R): Negative gradient of electric potential is electric field. 1

13. **Assertion (A):** A convex mirror cannot form real images.

Reason (R): Convex mirror converges the parallel rays that are incident on it. 1

14. **Assertion (A):** A convex lens of focal length 30 cm can't be used as a simple microscope in normal setting.

Reason (R): For normal setting, the angular magnification of simple microscope is M=D/f. 1

SECTION - B **8 marks**

Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

15. **Faraday Cage:** A Faraday cage or Faraday shield is an enclosure made of a conducting material. The fields within a conductor cancel out with any external fields, so the electric field within the enclosure is zero. These Faraday cages act as big hollow conductors you can put things in to shield them from electrical fields. Any electrical shocks the cage receives, pass harmlessly around the outside of the cage.

(A) Which of the following material can be used to make a Faraday cage?

(a) Plastic (b) Glass

(c) Copper (d) Wood 1

(B) Example of a real-world Faraday cage is:

(a) car (b) plastic box

(c) lightning rod (d) metal rod 1

(C) What is the electrical force inside a Faraday cage when it is struck by lightning?

(a) The same as the lightning (b) Half that of the lightning

(c) Zero (d) A quarter of the lightning 1

(D) An isolated point charge +q is placed inside the Faraday cage. Its surface must have charge equal to:

(a) Zero (b) +q

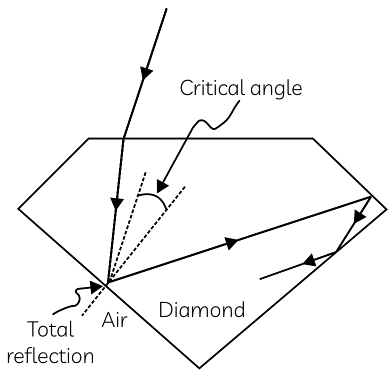
(c) –q (d) +2q 1

(E) A point charge of 2C is placed at centre of Faraday cage in the shape of cube with surface of 9 cm edge. The number of electric field lines passing through the cube normally will be:

(a) 1.9105 Nm^2/C entering the surface (b) 1.9105 Nm^2/C leaving the surface

(c) 2.0105 Nm^2/C leaving the surface (d) 2.0105 Nm^2/C entering the surface 1

16. Sparking Brilliance of Diamond:



The total internal reflection of the light is used in polishing diamonds to create a sparking brilliance. By polishing the diamond with specific cuts, it is adjusted the most of the light rays approaching the surface are incident with an angle of incidence more than critical angle. Hence, they suffer multiple reflections and ultimately come out of diamond from the top. This gives the diamond a sparking brilliance.

(A) Light cannot easily escape a diamond without multiple internal reflections. This is because:

(a) Its critical angle with reference to air is too large

(b) Its critical angle with reference to air is too small

(c) The diamond is transparent

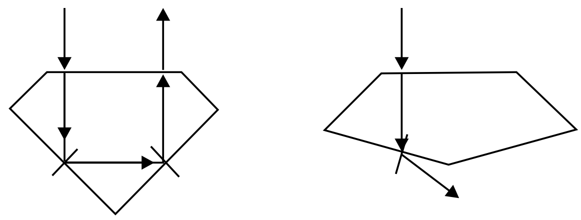
(d) Rays always enter at angle greater than critical angle 1

(B) The critical angle for a diamond is 24.4°. Then its refractive index is:
(a) 2.42 (b) 0.413
(c) 1 (d) 1.413 1

(C) The basic reason for the extraordinary sparkle of suitably cut diamond is that
(a) It has low refractive index (b) It has high transparency
(c) It has high refractive index (d) It is very hard 1

(D) A diamond is immersed in a liquid with a refractive index greater than water. Then the critical angle for total internal reflection will
(a) will depend on the nature of the liquid
(b) decrease
(c) remains the same
(d) increase 1

(E) The following diagram shows same diamond cut in two different shapes.



The brilliance of diamond in the second diamond will be:
(a) less than the first (b) greater than first
(c) same as first (d) will depend on the intensity of light 1

SECTION - C **18 marks**

All questions are compulsory. In case of internal choices, attempt any one.

17. Two straight infinitely long wires are fixed in space so that the current in the left wire is 2 A and directed out of the plane of the page and the current in the right wire is 3 A and directed into the plane of the page. In which region(s) is/are there a point on the x-axis, at which the magnetic field is equal to zero due to these currents carrying wires? Justify your answer. 2

18. Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through single slit.

OR

What should be the width of each slit to obtain n maxima of double slit pattern within the central maxima of single slit pattern? 2

19. Deduce an expression for the potential energy of a system of two point charges q_1 and q_2 located at positions r_1 and r_2 respectively in an external field $(\vec{E})$.

OR

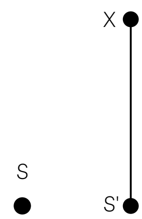
Establish the relation between electric field and electric potential at a point.

Draw the equipotential surface for an electric field pointing in +Z direction with its magnitude increasing at constant rate along –Z direction. 2

20. Explain with help of circuit diagram, the action of a forward biased p-n junction diode which emits spontaneous radiation. State the least band gap energy of this diode to have emission in visible region. 2

21. A coil of wire enclosing an area 100 cm^2 is placed with its plane making an angle 60° with the magnetic field of strength 10^{-1}T. What is the flux through the coil? If magnetic field is reduced to zero in 10^{-3}s, then find the induced emf? 2

22. Two waves from two coherent sources S and S' superimpose at X as shown in the figure. If X is a point on the second minima and SX – S'X is 4.5 cm. Calculate the wavelength of the waves.



2

23. Draw the energy band diagram when intrinsic semiconductor (Ge) is doped with impurity atoms of Antimony (Sb). Name the extrinsic semiconductor so obtained and majority charge carriers in it. 2

24. Define the terms magnetic inclination and horizontal component of earth's magnetic field at a place. Establish the relationship between the two with help of a diagram.

OR

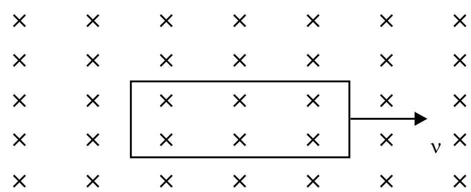
Horizontal component of earth's magnetic field at a place is √3 times the vertical component. What is the value of inclination at that place? 2

25. Write two characteristics of image formed when an object is placed between the optical centre and focus of a thin convex lens. Draw the graph showing variation of image distance v with object distance u in this case. 2

SECTION - D **15 marks**

All questions are compulsory. In case of internal choices, attempt any one.

26. A rectangular loop which was initially inside the region of uniform and time - independent magnetic field, is pulled out with constant velocity v as shown in the figure.



(A) Sketch the variation of magnetic flux, the induced current, and power dissipated as Joule heat as function of time.

(B) If instead of rectangular loop, circular loop is pulled out; do you expect the same value of induced current? Justify your answer. Sketch the variation of flux in this case with time. 3

27. A variable resistor R is connected across a cell of emf E and internal resistance r.

(A) Draw the circuit diagram.

(B) Plot the graph showing variation of potential drop across R as function of R.

(C) At what value of R current in circuit will be maximum?

OR

A storage battery is of emf 8 V and internal resistance 0.5 ohm is being charged by d.c supply of 120 V using a resistor of 15.5 ohm

(A) Draw the circuit diagram.

(B) Calculate the potential difference across the battery.

(C) What is the purpose of having series resistance in this circuit? 3

28. (A) Explain de-Broglie argument to propose his hypothesis. Show that de-Broglie wavelength of photon equals electromagnetic radiation.

(B) If, deuterons and alpha particle are accelerated through same potential, find the ratio of the associated de-Broglie wavelengths of two.

OR

State the main implications of observations obtained from various photoelectric experiments. Can these implications be explained by wave nature of light? Justify your answer. 3

29. Derive an expression for the frequency of radiation emitted when a hydrogen atom de-excites from level n to level (n – 1). Also show that for large values of n, this frequency equals to classical frequency of revolution of an electron. 3

30. (A) Give one point of difference between nuclear fission and nuclear fusion.

(B) Suppose we consider fission of a$^{56}{}_{26}$Fe into two equal fragments of $^{28}{}_{13}$Al nucleus. Is the fission energetically possible? Justify your answer by working out Q value of the process.

Given (m)$^{56}{}_{26}$Fe = 55.93494 u and (m)$^{28}{}_{13}$Al = 27.98191 3

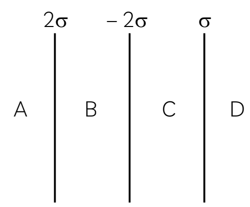
SECTION - E

15 marks

All questions are compulsory. In case of internal choices, attempt any one.

31. (A) State Gauss's law in electrostatics. Show that with help of suitable figure that outward flux due to a point charge Q, in vacuum within gaussian surface, is independent of its size and shape.

(B) In the figure there are three infinite long thin sheets having surface charge density +2σ, –2σ and +σ respectively. Give the magnitude and direction of electric field at a point to the left of sheet of charge density +2σ and to the right of sheet of charge density +σ.



OR

(A) Define an ideal electric dipole. Give an example.

(B) Derive an expression for the torque experienced by an electric dipole in a uniform electric field. What is net force acting on this dipole.

(C) An electric dipole of length 2cm is placed with its axis making an angle of 60° with respect to uniform electric field of 10^5N/C. If it experiences a torque of 8√3 Nm, calculate the (i) magnitude of charge on the dipole, and its potential energy. 5

32. (A) Derive the expression for the current flowing in an ideal capacitor and its reactance when connected to an ac source of voltage $V = V_0 \sin\omega t$.

(B) Draw its phasor diagram.

(C) If resistance is added in series to capacitor what changes will occur in the current flowing in the circuit and phase angle between voltage and current?

OR

(A) State the principle of ac generator.

(B) Explain with the help of a well labelled diagram, its working and obtain the expression for the emf generated in the coil.

(C) Is it possible to generate emf without rotating the coil? Explain. 5

33. (A) Define a wave front.

(B) Draw the diagram to show the shape of plane wave front as they pass through (i) a thin prism and (ii) a thin convex lens. State the nature of refracted wave front.

(C) Verify Snell's law of refraction using Huygens's principle.

OR

(A) State two main considerations taken into account while choosing the objective of astronomical telescope.

(B) Draw a ray diagram of reflecting type telescope. State its magnifying power.

(C) State the advantages of reflecting type telescope over the refracting type? 5

1

SOLUTION
WITH CBSE MARKING SCHEME

Note: The text is all grey boxes are solutions given in the CBSE Marking Scheme 2020-2021.

SECTION - A

1. *Magnetic dipole moment*

Explanation: Torque acting on a current carrying loop in a uniform magnetic field is given by

$$\tau = i\ AB\ \sin\theta$$

Where A is area of the loop and B is the magnetic field in which loop is placed. If Current carrying loop has N turns then torque τ = Ni AB Sin θ, in which term NiA is defined as the magnitude of the dipole moment $\vec{m}$ of the coil.

$$\tau = mB\ \sin\theta$$

For Unit, N – , = m × Tesla

$$\text{Unit of } m = \frac{N-m}{Tesla}\ J/T$$

Related Theory

➥ *Dimension of* m $= \dfrac{[ML^2T^{-2}]}{[MA^{-1}A^{-2}]}$

$= [AL^2]$

2. *Any one use of micro waves*

Explanation: Radio waves have wavelengths of 1 mm to 100 km. Hence, 21 cm lies at short wavelength end of radio waves.

Uses : In T.V. and radio communication systems.

OR

1:1

Explanation: All Electromagnetic waves travel in vaccum with same speed equal to speed of light 3×10^8 m/s. So ratio of their velocities in vaccum will be 1 : 1 irrespective of their wavelengths.

3. *Zero*

Explanation: When a charged particle having mass m carrying charge q enters in the magnetic field of magnitude B such that it acquires circular path, then definitely force acting on the particle will be perpendicular to applied magnetic field, i.e. particle moves under a force whose magnitude remains constant but direction changes continuously and is always perpendicular to the velocity. As a result particle always follow circular path with constant speed *v*, the force acting on particle as the centripetal force $F = \dfrac{mv^2}{r} = qVB$

Now workdone in moving the particle

$$W = \vec{F}.\vec{S} = FS\cos 90^\circ$$

$$= 0 \text{ Joule.}$$

4. *Remains same*

Explanation: When current i is passed through a long air-cored solenoid of length l and area of cross-section A, having N closely-wound turns, then coefficient of self inductance becomes

$$L = \frac{\mu N^2 A}{l},$$

where $\mu = \mu_0\ \mu_r$ (μ_r being the relative permeability)

Since it does not depend on the current so on changing the current through solenoid, there will be no change in inductance.

OR

7.707A, 50Hz

Explanation: For given alternating current source

i = 10 sin 314t

$i = i_0 \sin\omega t$

$= i_0 = 10$ $\omega = 314$

$i_{rms} = \dfrac{i_0}{\sqrt{2}}$ $2\pi f = 314$

$= \dfrac{10}{\sqrt{2}}$ $2\times3.14\times f = 314$

$= 5\sqrt{2}$ $f = 50$ Hz

$= 5\times1.414$

$= 7.07$ A

Related Theory

➥ *For one complete cycle the mean value of alternating current is zero. The mean value of A.C. for a half-cycle is 0.637 times or 63.7% of the peak value.*

5. *h/π*

Explanation: For an electron having mass m revolving around the nucleus with velocity v in a orbit of radius r, angular momentum is given by *mvr*. According to Bohr's postulate electrons can revolve only in those orbits in which their angular momentum is an integral multiple of $\frac{nh}{2\pi}$, where *h* is planck's universal constant.

$$mvr = \frac{nh}{2\pi}$$

For second orbit $n = 2$

$$\text{angular momentum} = \frac{2h}{2\pi} = \frac{h}{\pi}$$

6. *4eV*

Explanation: Since the stopping potential stops the maximum energy electrons, it is a measure of the maximum kinetic energy of the electrons. If the stopping potential be V_0, then the maximum kinetic energy E_k of the photoelectrons will be given by

$E_k = eV_0$, where e is the charge on the electron.

For stopping potential $V_0 = 4V$

$$E_k = 4e \text{ Joule}$$
$$= 4 \text{ eV}$$

7. *Antinutrino*

Explanation: At the time of emission of a β - particle from a radioactive nucleus, a neutron in the nucleus is converted into a proton and in this process a new particle called antineutrino $(\bar{\nu})$ is also generated.

$${}_0n^1 \longrightarrow {}_1H^1 + {}_{-1}B^0 + \bar{\nu}$$

neutron proton electron antineutrino

OR

Electron

Explanation:

$$_{11}Na^{22} + x \rightarrow {}_{10}Ne^{22} + \nu_e$$

$$_{11}Na^{22} + {}_{-1}\beta^0 \rightarrow {}_{10}Ne^{22} + \nu_e$$

electron

In the given above equation atomic number is decreased by 1 and there is no change in atomic mass of the decaying nucleus, which is possible with the emission of β - particle only.

Related Theory

When an α-particle is emitted from the nucleus of a radioactive atom, the atomic number decreases by 2 and the mass number decreases by 4.

8. *Decreases*

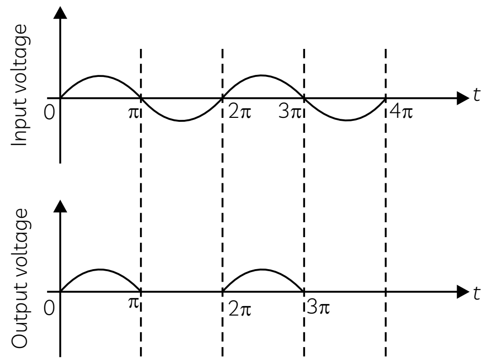
Explanation: The process of adding impurity to an intrinsic semiconductor in a controlled manner is called doping. It increases significantly the electrical conductivity of the semiconductor. With the increase in the rate of doping the thickness of the depletion layer generated at the junction decreases. Even if one part of a p–n junction is heavily doped, the thickness of depletion layer on that side (p-side) becomes less than that of other side.

OR

25 Hz

Explanation: Rectifier connects an alternating current (or voltage) into direct (unidirectional) current (or voltage).

The output current corresponds to one half of the input voltage wave, there will be no change in frequency of the input applied.



Related Theory

The ratio of effective alternating component of the output voltage or current the d.c. component is known as ripple factor.

$$r = \frac{I_{ac}}{I_{de}} = \left[\left(\frac{I_{rms}}{I_{de}}\right)^2 \quad 1\right]^{1/2} = 1.21$$

9. *Dynamic resistance =change in voltage/change in current = 1 ohm*

Explanation: Change in voltage drop across a pn junction diode = 0.71 – 0.70

$$\Delta V = 0.01 \text{ V}$$

Change in diode current $\Delta i = 10 \text{ mA} = 10 \times 10^{-3}$A

$$\text{Dynamic resistance } R_d = \frac{\Delta v}{\Delta i}$$
$$= \frac{0.01}{10 \times 10^{-3}} = \frac{0.01}{0.01}$$
$$= 1\ \Omega$$

Related Theory

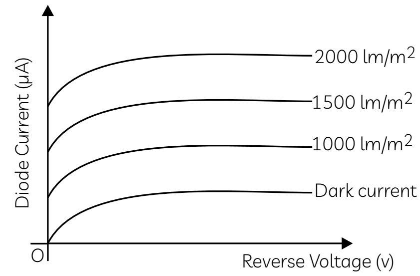
In the forward characteristic of p–n junction diode, however, beyond the turning point, the current varries almost linearly with voltage. In this region, R_d is almost independent of V and ohm's law is obeyed.

10. *Photodiode*

Explanation: Photodiode is a reverse-biased p–n junction made from a photosensitive semiconductor. Its upper surface is open to light while the remaining sides of the plastic are painted black.

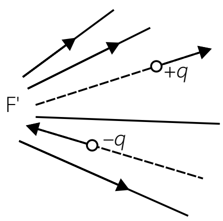
Related Theory

Given figure represents the voltage-ampere characteristic curve for three different values of Ge photodiode. Only dark current passes through origin. Current increases with increase in illumination for a given reverse voltage.



11. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation : When an electric dipole is kept in a non-uniform electric field f_{net} (not equal to symbol) 0, T_{net} = (not equal to symbol) 0.



In this case motion of the dipole is combination of translatory and rotatory motion.

Related Theory

When a dipole is kept in uniform electric field, the net translatory force on the dipole is zero, therefore there will be translatory motion of the dipole in a uniform electric field.

12. *(b) Both A and R are true but R is NOT the correct expalnation of A.*

Explanation: For a uniform electric field, equipotential surfaces are a family of planes perpendicular to the lines of force.

The electric field intensity at a point in an electric field in a given direction is equal to the negative potential gradient in that direction.

$$E = -\frac{dv}{dx}$$

Related Theory

In a family of equipotential surfaces the surfaces are closer together where the electric field is stronger and further apart where the field is weaker.

13. *(c) A is true but R is false*

Explanation: Convex mirrors light rays from a point always gets diverged (they don't meet at any point) . Since image is formed behind of mirror, they cant be received on screen. So it is not real image.

14. *(b) Both A and R are true but R is NOT the correct explanation of A.*

Explanation: In the simple microscope or magnifying glass is just a thin, short-focus convex lens carrying a handle. The object to be seen is placed between the lens and its focus and the eye is placed just behind the lens. The position of object between the lens and its focus is so adjusted that the image is formed at the least distance of distinct vision (D) from the eye.

Magnification power $M = 1 + \frac{D}{f}$

It is clear that shorter the focal length of the lens, larger is the magnifying power.

For relaxed eyes, image is formed at infinity. In this case object will be at focus of the lens.

Magnification power $m = \frac{D}{f}$.

SECTION - B

15. (A) *(c) Copper*

Explanation: A foraday cage is a container made of conductiong material, such as wire mesh or metal plates which is used to block electromagnetic fields. A Foraday cage operates because an external electric field causes the electric charges within the cage's conducting material to be distributed so that they cancel the field's effect in the cage's interior.

(B) *(a) Car*

(C) *(c) Zero*

Explanation: The protective metal compartment of a car acts as a faraday cage to protect its passengers from external electric charges such as lightning.

It works because an outside electric field causes a redistribution of the electric charges within the enclosure's conducting material, which in turn cancel's the field's effect in the cage's interior.

(D) *(c) -q*

Explanation: Since E = 0 inside the faraday cage, so flux through this, surface = 0.

According to Gauss's law total charge enclosed by the faraday cage = 0.

So all charge goes on outer surface.

(E) *(b) 1.9×10^5 Nm^2/C leaving the surface*

Explanation: Given $q = 2\ \mu C = 2 \times 10^{-6}$ C

Since cube has 6 symmetrical faces in which charge is placed at the centre of the cube. If flux through any one surface be ϕ_ε then total flux through the cube will be $6\phi_\varepsilon$

By Gauss's theorem,

$$6\phi_\varepsilon = \frac{q}{\varepsilon_0} = \frac{2\times10^{-6}}{8.85\times10^{-12}}$$
$$= 0.22598\times10^6$$
$$= 2.26\times10^5 \text{ Nm}^2/\text{C}$$

Which is close to option (c).

16. (A) *(b) Its critical angle with reference to air is too small.*

Explanation: The brilliancy of a diamond is due to small critical angle with respect to air. The light which enters the diamond is totally reflected repeatedly at the various faces of the diamond and emerges only when the angle of incidence at some faces is less than the critical angle. As a result all the light entering the diamond emerges in a few directions only and the diamond sparkles brilliantly when seen along these directions.

(B) *(a) 2.42*

Explanation: The critical angle for a diamond 24.4°

For total internal reflection,

refractive index $n = \frac{1}{\sin C} = \frac{1}{\sin 24.4°} = 2.42$

Related Theory

Since refractive index depends upon the wavelength of light, the critical angle for a given pair of media is different for different wavelengths (colours) of light.

(C) *(c) It has high refractive index.*

Explanation: Due to high refractive index of the material of diamond its critical angle is less. Only light rays having angle of incidence less than 24° comes out, rest of rays undergoes repeatedly reflection, which causes extraordinary sparkle.

(D) *(d) Increase*

Explanation: When diamond is immersed in a liquid with a refractive index greater than water, then its resultant refractive index will decrease. As a result critical angle will increase since

$$n = \frac{1}{\sin C}$$

(E) *(a) Less than first.*

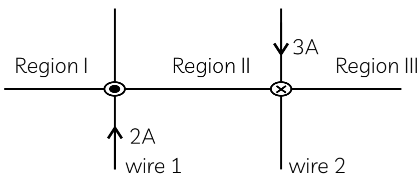
Explanation: More the total internal reflection of light ray at the various faces of the diamond, it will cause more the brilliance of diamond.

In second diamond total internal reflection is occuring only at one face while in first diamond total internal reflection is occuring at two surfaces. So brilliance of diamond in the second diamond will be less than the first.

SECTION - C

17. Explanation by showing magnetic field directions in all three regions Concluding left of region 1

Explanation:



The direction of magnetic field intensity $\vec{B}$ at any point on the x-axis can be calculated by right hand palm rule no. 1 (or Maxwell's right hand screw rule), $\vec{B}$ is perpendicular to the plane of page.

Due to wire (1) magnetic field intensity to the left of it will be perpendicular to the plane of page outward and due to wire (2) will be downward. So region I direction of magnetic field intensity will be opposite. So resultant intensity can be zero.

$$\vec{B} = \vec{B}_1 + \vec{B}_2$$

$$\Rightarrow \quad B = B_1 - B_2 = \frac{\mu_0}{2\pi}\left[\frac{i_1}{R_1} - \frac{i_2}{R_2}\right]$$

In region II magnetic field intensity due to both wires will be perpendicular to the plane of paper downward, so it cannot be zero.

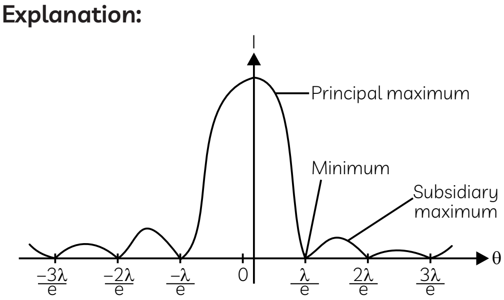
$$B = B_1 + B_2.$$

In region III magnetic field intensity due to wire (1) will perpendicular to plane of paper downward and due to wire (2) it will be perpendicular to the plane of paper outward. So resultant magnetic field intensity.

$$B = B_1 - B_2$$
$$= \frac{\mu_0}{2\pi}\left[\frac{i_1}{R_1} - \frac{i_2}{R_2}\right]$$

18. Plot of Intensity distribution of diffraction with proper labeling

Explanation:



In diffraction pattern a central bright band having on both sides narrower alternately dark and bright bands of decreasing intensity will obtain. If the intensity of the central maxima is I_0 then the intensity of the first and second secondary maxima are found to be $\frac{I_0}{22}$ and $\frac{I_0}{61}$.

Thus diffraction fringes are of unequal width and unequal intensities.

OR

$n\lambda/d = 2\lambda/a$

$n = 2d/a$, where d is separation between slit and a width of slit.

Explanation: Let width of single slit = a

Distance between slits = d

In Young's double slit experiment,

Separation between n maxima is given by

$$Y_n = \frac{n\lambda D}{d}$$

Angular separation between n maxima is given by

$$\theta_n = \frac{n\lambda}{d}$$

Path difference = a sinθ = aθ = λ

$$\Rightarrow \quad \theta = \frac{\lambda}{a}$$

The angular width of the central maximum in the diffraction pattern due to single slit of width a is given by

$$2\theta = 2\frac{\lambda}{a}$$

According to question to obtain n maxima of double slit pattern within the central maxima of single slit pattern,

$$\frac{n\lambda}{d} = \frac{2\lambda}{a}$$

$$\Rightarrow \quad n = \frac{2d}{a}$$

$$\Rightarrow \quad a = \frac{2d}{n}$$

19. *Derivation including both terms electrostatic energy in system and in external field*

Explanation: Expression for the potential energy of a system of two point charges in an external electric field $\vec{E}$:

Let two point charges q_1 and q_2 are located at r_1 and r_2 respectively, in an external electric field.

Workdone to bring a charge q_1 in the electric field at distance $\vec{r}_1 = q_1 V(\vec{r}_1)$

Workdone to bring a charge q_2 in the electric field at distance $\vec{r}_2 = q_2 V(\vec{r}_2)$

Workdone on charge q_2 against the field due to $q_1 = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{\vec{r}_{12}}$, where $\vec{r}_{12}$ is the distance between charge q_1 and q_2.

By the principle of superposition for fields, work done on q_2 against two fields will add with workdone in bringing q_2 to r_2, which is given as

$$w_2 + w_{12} = q_2 V(\vec{r}_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 \vec{r}_{12}}$$

So potential energy of the system

= total workdone in assembling the configuration U

$= w_1 + w_2 + w_{12}$

$$U = q_1 V(\vec{r}_1) + q_2 V(\vec{r}_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 \vec{r}_{12}}$$

OR

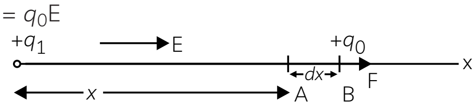
Derivation of relation E = -dV/dr

Diagram of equipotential surfaces

Explanation: Relationship between electric field and electric potential at a point :

Let a small positive test charge q_0 is moved in the electric field from point B to A. Potential at point A is V and at point B is (V – dV).

Force acting on q_0 in the direction of electric field $F = q_0 E$



So to move the charge from B to A, an external agent will have to work against the force F.

$dW = F(-dx)$

Where ($-dx$) is the magnitude of the displacement from B to A.

$$dW = -q_0 E dx$$

$$\frac{dW}{q_0} = -E dx \quad ...(i)$$

By the definition of potential difference

$$\frac{dW}{q_0} = V - (V - dv) = dv \quad ...(ii)$$

From eqns (i) & (ii)

$$-E dx = dv$$

$$E = -\frac{dv}{dx}$$

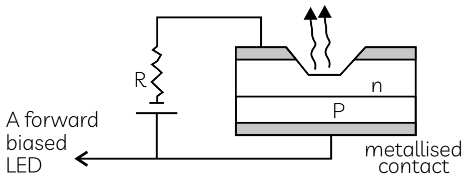
20. *Circuit diagram showing biasing of LED in F.B*

Action of LED

For emission in visible range least band energy required is 1.8eV

Explanation: LED is forward biased p–n junction which emits light spontaneously converts the biasing electrical energy into optical energy, like infrared and visible light.

When the p–n junction is forward biased, electrons are sent from n region to p–region (where they are minority carriers) and holes are sent from p region to n region (where they are minority carriers). Near the junction, the concentration of minority carriers increases as compared to equilibrium concentration. On either side near junction, the excess minority carriers combine with the majority carriers. On recombination, the energy is released in the form of photons. Photons with energy equal to or slightly less than the band gap are emitted. When the forward bias of the diode is small, the intensity of emitted light is small. As the forward current increases, intensity of light increases and reaches a maximum. Further, increase in forward current decreases the light intensity.



For emission in visible range least band energy required is 1.8 eV.

21. Calculation of magnetic flux ϕ = BA cosθ ,where θ = 30° = $\sqrt{3}$ /2 × 10^{-11}Wb

Calculation of induced emf E = A cosθdB/dt = 0.5 V

Explanation: For given coil,

$$\text{Area} = 100\ \text{cm}^2,\ \theta = 90° - 60° = 30°$$
$$= 100\times10^{-4}\text{m}^2$$
$$B = 10^{-1}\text{T}$$
$$\text{Flux } \phi = ?$$

When a coil having area A is placed in magnetic field B,

{Where θ is the angle between area vector and magnetic field vector

flux passing through coil ϕ = BA cosθ,

$$= 10^{-1}\times100\times10^{-4}\cos30°$$
$$= 10\frac{\sqrt{3}}{2} = 5\sqrt{3}\ \text{Wb}$$

Now magnetic field is reduced to zero in 10^{-3} s

i.e. $\Delta\phi = 5\sqrt{3}-0 = 5\sqrt{3}$ Wb

induced emf

$$e = -\frac{\Delta\phi}{\Delta t} = \frac{5\sqrt{3}}{10^{-3}}$$
$$= -500\,0\sqrt{3}\ \text{volt}$$

Here negative sign indicate that induced emf opposes the change of flux.

Related Theory

Magnetic flux is a scalar quantity. It's CGS unit is maxwell or (gauss×cm²).

$$1\ \text{Wb} = 10^8\ \text{maxwell}$$

Other units : tesla×m^2 = $\frac{\text{N}\times\text{m}}{\text{Ampere}} = \frac{\text{Joule}}{\text{Ampere}}$

$$= \frac{\text{Volt}\times\text{Coulomb}}{\text{Ampere}} = \text{Volt}\times\text{sec}$$

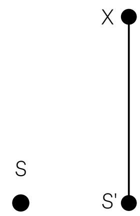
= ohm × coulomb = henry × Ampere

Dimensional formula [ϕ] = [$ML^2T^{-2}A^{-1}$]

22. Path difference = 3λ/2

Putting value we will get λ = 3 cm

Explanation:



For two given waves travelling from two coherent sources S and S', X is a point of on the second minima.

SX – S'X = 4.5 cm

Wavelength of the waves λ = ?

When two waves travelling from two coherent sources superimpose to each other, interference pattern is obtained.

For the minimum intensity,

$$\text{path difference } x = (2n-1)\frac{\lambda}{2}$$

For second minima n = 2

$$x = \frac{3\lambda}{2}$$
$$4.5 = \frac{3\lambda}{2} = \lambda = 3\ \text{cm}.$$

Related Theory

The ratio of intensities of light at maxima and minima is the ratio of intensities of bright and dark fringes.

$$\frac{I_{max}}{I_{min}} = \frac{(a_1+a_2)^2}{(a_1\sim a_2)^2},$$

Where a_1 and a_2 are amplitudes of two light waves.

23. Well labeled energy band diagram of n-type semiconductor

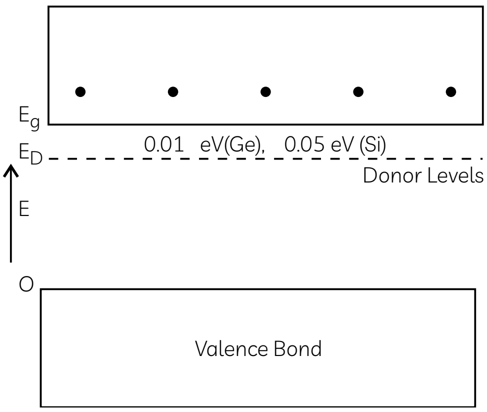
n-type semiconductor

electrons-majority charge carriers

Explanation: Energy band diagram when intrinsic semiconductor (Ge) is doped with impurity atoms of Antimony (Sb):

When a pentavalent impurity atom like antimony, phosphorous or arsenic is added to Ge or (si) crystal, it replaces a Ge (or Si) atom in the crystal lattice. Four electrons of impurity atom form covalent bonds with four electrons of Ge and fifth electron becomes free to move and acts as a charge carrier.

The fifth valence electrons of the impurity atoms occupy some discrete energy levels just below the conduction band. At room temperature these the fifth electrons of almost all the donor atoms are thermally excited from the donor levels into the conduction band. At room temperature the thermal excitation from the valence band is small, there are very few holes in this band.

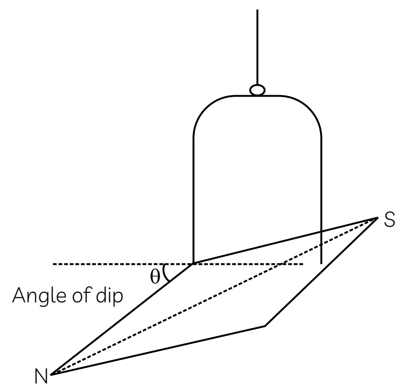


n–type exrinsic semiconductor is obtained by doping of impurity atoms of Antimony (Sb) in intrinsic semiconductor (Ge).

In n–type semiconductors majority charge carriers are electrons.

24. Definition of each term.
Diagram showing relation

Explanation: The angle of dip at a place is the angle between the direction of earth's magnetic field and the horizontal in the magnetic meridian at that place.

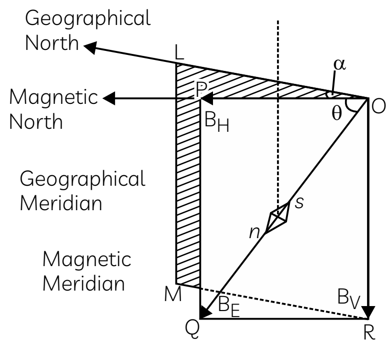


Horizontal component of Earth's Magnetic field:

The component of earth's magnetic field in the horizontal direction in the magnetic meridian is equal to the horizontal component of earth's magnetic field.

Here, is a dip needle. The vertical plane OPQR passing through the axis of the needle is the magnetic meridian. The plane OLMR is the geographical meridian. The angle α between these two planes is the angle of declination. The angle between the axis OQ of the dip needle and the horizontal OP is the angle of dip θ.

The axis OQ of the needle represents the direction of earth's magnetic field B_E. The field B_E may be resolved into a horizontal component of earth's magnetic field, B_H , and a vertical component of earth's magnetic field, B_V. From figure, we have



$$B_H = B_E \cos\theta$$

and $$B_V = B_E \sin\theta,$$

where θ is the angle of dip. These equations give

$$B_E = \sqrt{B_H^2 + B_V^2}$$

and $$\left(\frac{B_V}{B_H}\right) = \tan\theta$$

or $$\theta = \tan^{-1}\left(\frac{B_V}{B_H}\right).$$

OR

$B_V/B_H = \tan\theta$
Putting values, $\theta = 30°$

Explanation: Horizontal component of earth's magnetic field $B_H = \sqrt{3} \times$ Vertical component of earth's magnetic field (B_V)

We have $\tan\theta = \frac{B_V}{B_H}$, where θ is the angle of inclination.

$$= \frac{B_V}{\sqrt{3}B_V} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad \theta = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

$$\theta = 30^\circ.$$

25. Two characteristics- virtual and enlarged image and same side of object.
As u and v both negative, we get $\frac{1}{v} = \frac{1}{u} - \frac{1}{f}$
Interpret y = mx + c, plot of the graph.

Explanation: Characteristics of image formed when an object is placed between the optical centre and focus of a thin convex lens :

(i) Virtual and erect image is formed on the same side of the lens as the object.

(ii) Image size is larger than object.

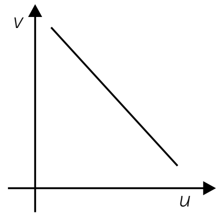
By using the lens maker's formula

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\Rightarrow \quad \frac{1}{v} = \frac{1}{u} + \frac{1}{f},$$

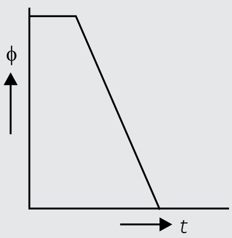
In the given case both u and v are negative,

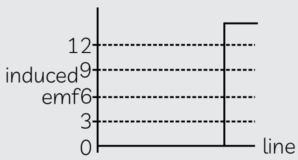
So $\frac{1}{v}=\frac{1}{u}-\frac{1}{f}$, which depicts a straight line represented by y = mx+c.



SECTION - D

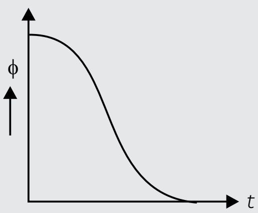
26. (A)





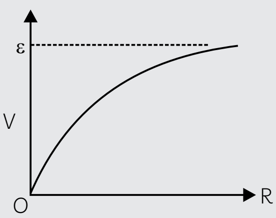
Induced current and power, sketch is same as shown above.

(B) In case of circular coil, rate of change of area of the loop during its passage out of field is not constant, hence induced current varies accordingly.



27. (A) Circuit diagram

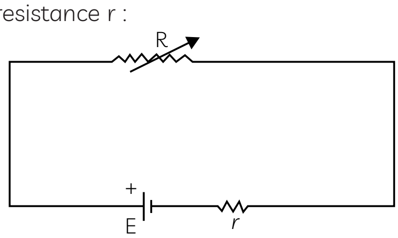
(B)



(C) Maximum current drawn will be at R = 0.

Detailed Answer:

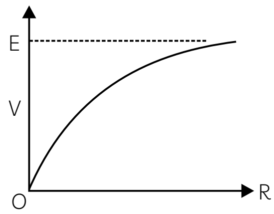
(A) Circuit diagram for a variable resistors R connected across a cell of emf E and internal resistance r :



Variable resistor R will be in series combination with internal resistance r.

Net resistance R_{eq} = (R + r)

(B) Potential drop across the resistor R will be maximum, when internal resistance of the battery will be zero.



V = E – ir

(C) Current flowing in the circuit,

$$i = \frac{E}{R+r}$$

For the current to be maximum, value of (R+r) should be minimum. Since practically r can not be zero because of material of electrolyte used, so to draw maximum current R will be zero.

OR

(A) Circuit diagram

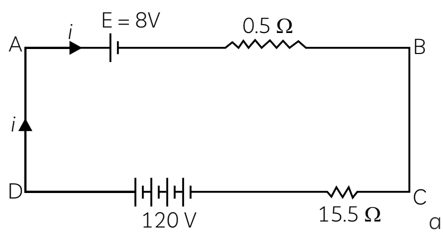
(B) Applying correct formula

And calculation of p.d=11.5 V

(C) Series resistor limits the current drawn from source.

Detailed Answer:

(A)



When a battery is charged by using an external D.C. supply current will flow from positive terminal of battery to the negative (i.e. in the reverse direction).

(B) By using KVL,

$$8 + 0.5\times i + 15.5\times i - 120 = 0$$

$$\Rightarrow \quad 16\,i - 112 = 0$$

$$\Rightarrow \quad i = 7\text{ A}$$

When battery is charged, potential difference across the battery

$$V = E + ir$$
$$= 8 + 7 \times 0.5 = 8 + 3.5$$
$$= 11.5 \text{ Volt}$$

(C) Series resistor of resistance 15.5 Ω is used in the given circuit to limit the current drawn from the source.

28. (A) De-Broglie reasoned out that nature was symmetrical and two basic physical entities –mass and radiation must be symmetrical. If radiation shows dual aspect than matter should do so.

De-Broglie equation-

$$\lambda = \frac{h}{P}$$

For photon –

$$P = \frac{h\nu}{C}$$

Therefore, $\frac{h}{P} = \frac{C}{\nu} = \lambda$

(B) As $\lambda = \frac{h}{\sqrt{2mk}}$

So, alpha particle will be having shortest de-Broglie wavelength compared to deuterons.

Detailed Answer:

(A) de–Broglie reasoned out that matter possesses momentum (p = mv) and kinetic energy ($K = \frac{1}{2} mv^2$). So matter is supposed to have a particle nature. In 1924, de–Broglie introduced a bold hypothesis that, like radiation, matter should, have dual nature. He reached on this conclusion on the basis of that the entire universe is composed of matter and electromagnetic radiation and that nature loves symmetry.

So according to de–Broglie, all material particles in motion have wave nature also. According to quantum theory of radiation, energy of photon $E = h\nu$

By Einstein's mass-energy relation $E = me^2$

$$\Rightarrow \quad m = \frac{E}{C^2} = \frac{h\nu}{C^2}$$

Momentum of photon $p = m \times c = \frac{h\nu}{c^2} \times c$

$$p = \frac{h\nu}{c} = \frac{hc}{c\lambda} \quad \left[\because \nu = \frac{c}{\lambda}\right]$$

$$\Rightarrow \quad \lambda = \frac{h}{P}$$

(B) The de–Broglie wavelength of V-volt electrons is given by

$$\lambda = \frac{h}{\sqrt{2mk}} = \frac{h}{\sqrt{2mqV}}$$

$$\frac{\lambda_d}{\lambda_d} = \frac{\sqrt{m_d q_d}}{\sqrt{m_\lambda q_\lambda}} = \sqrt{\frac{2 \times 1e}{4 \times 2e}} = \frac{1}{2}$$

Since both deuterons and alpha particles are accelerated through same potential,

$$\frac{\lambda_d}{\lambda_\alpha} = \frac{\sqrt{m_d q_d}}{\sqrt{m_\alpha q_\alpha}} = \sqrt{\frac{2 \times 1e}{4 \times 2e}} = \frac{1}{2}$$

Hence, the wavelength of deuteron is more than the wavelength of the alpha particle.

Mass of deuteron is equal to double of H atom and charge is same as that of H atom.

Mass of α particle is equal to 4 times of H atom and charge on it is double that of it.

So alpha particle will have shortest de–Broglie wavelengths composed to deuterons.

OR

Main implications:

1. Kinetic energy of emitted electrons depends upon frequency, but not on intensity of radiation.
2. There exist a frequency of radiation below which no photoemission takes place, how high intensity of radiation may be.

Explanation wave nature of radiation fails to explain photoelectric effect.

Detailed Answer:

Implications of observations obtained from various Photoelectric experiments:

Lenard and Millikan gave the following laws on tha basis of experiments on photoelectric effect :

(1) The rate of emission of photoelectrons from the surface of a metal varies directly as the intensity of the incident light falling on the surface.

(2) The maximum kinetic energy of the emitted photoelectrons is independent of the intensity of the incident light.

(3) The maximum kinetic energy of the photoelectrons increases linearly with increase in the frequency of the incident light.

(4) If the frequency of the incident light is below a certain lowest value, then no phtoelectron is emitted from the metal. This lowest frequency (threshold frequency) is different for different metals.

(5) As soon as the light is incident on the surface of the metal, the photoelectrons are emitted instantly, that is, there is no time-lag between incidence of light and emission of electrons.

Failure of Wave Theory: These characteristics of the photoelectric effect cannot be explained on the basis of the wave theory of light. It is due to three main reasons:

(1) According to the wave theory, the energy carried by a light beam is distributed uniformly over a wavefront and is measured by the intensity of the beam. Thus, when light falls on a metal surface, the energy of the wave should be transferred uniformly to the electrons in the surface before they are emitted out. Obviously, the energy taken up by the electrons must increase as the intensity of light is increased. This is against the experimental observation that the maximum energy of the emitted electrons is independent of the light intensity.

(2) According to the wave theory the light of any frequency, however low it is, should be capable of ejecting electrons from a surface, provided only that the light is intense enough. Experiment, however, shows that light of frequency lower than a certain threshold value cannot eject photoelectrons, no matter how intense it is.

(3) If the incident light is very feeble, the electron should take appreciable time before it acquires sufficient energy to come out from the surface. But there is no time-lag between incidence of the light on the surface and the emission of the photoelectrons.

Thus, wave theory fails in explaining the experimental observations regarding the photoelectric effect.

29. Derivation of frequency of radiation emitted when a hydrogen atom de excites from level n to level (n-1).

$$\nu = \frac{me^4(2n-1)}{(4\pi)^3\varepsilon_0^2\left(\frac{h}{2\pi}\right)^3 n^2(n-1)^2}$$

Comparing for large values of n, with classical freuency $v = \frac{v}{2\pi r}$

Detailed Answer: The frequency ν of emitted radiation when a hydrogen atom de-excites from level n to level (n–1) can be calculated as

$$e = h\nu = E_2 - E_1$$

$$\nu = \frac{E_2 - E_1}{h}$$

$$= \frac{mz^2e^4}{8\varepsilon_0{}^2h^3}\left[\frac{1}{n_1{}^2} - \frac{1}{n_2{}^2}\right]$$

In the given case $n_1 = (n-1)$ and $n_2 = n$

$$\nu = \frac{mz^2e^4}{8\varepsilon_0{}^2h^3}\left[\frac{1}{(n-1)^2} - \frac{1}{n^2}\right]$$

$$= \frac{mz^2e^4}{8\varepsilon_0{}^2h^3}\left[\frac{n^2-(n-1)^2}{n^2(n-1)^2}\right]$$

$$= \frac{mz^2e^4}{8\varepsilon_0{}^2h^3}\frac{(2n-1)}{n^2(n-1)^2}$$

For Large n, $2n - 1 \approx 2n$ and $n - 1 \approx n$

$$\nu = \frac{mz^2e^4 \times 2n}{8\varepsilon_0{}^2h^3 n^2 \times n^2} = \frac{mz^2e^4}{4\varepsilon_0{}^2h^3n^3}$$

For hydrogen atom z = 1

$$\nu = \frac{me^4}{4\varepsilon_0{}^2h^3n^3} \quad \text{...(i)}$$

In Bohr's atomic model,

velocity of electron in n^{th} orbit is $v = \frac{nh}{2\pi mr}$

radius of orbital path $r = \frac{n^2h^2\varepsilon_0}{\pi mze^2}$

frequency of revolution $\nu = \frac{v}{2\pi r} = \frac{nh}{2\pi mr(2\pi r)}$

$$= \frac{nh}{4\pi^2mr^2} = \frac{me^4}{4\varepsilon_0{}^2h^3n^3} \quad \text{...(ii)}$$

From eqns (i) & (ii) we can say that for large values of n, frequency of radiation emitted when a hydrogen atom de-excites from level n to level (n–1) is same as that of classical frequency of revolution of an electron.

30. (A) One difference between nuclear fission and nuclear fusion

(B) Calculating Q = ((m) Fe - 2(m) Al)C^2 = 26.90 MeV

Justification not possible

Detailed Answer:

(A) Difference between Nuclear fission and nuclear fusion: *(Write any one)*.

(1) In fission when neutrons are bombarded on a heavy nucleus, it splits in two nearly equal weight framents while in fusion, at a very high temperature and high pressure two light nuclei combine to form a heavy nucleus.

(2) For the same mass, the energy released in fusion process is much more than that in the fission process.

(3) Fission process can be controlled. Nuclear reactor is based on the controlled fission reaction. Fusion reaction can not be controlled. This is why fusion reactor could not be constructed so far.

(B) In the process of fission of ${}_{26}fe^{56}$, let energy Q be released.

$${}_{26}fe^{56} \longrightarrow 2\,{}_{13}Al^{28} + Q$$

Given (m) ${}_{26}fe^{56}$ = 55.93494 U

(m) ${}_{13}AL^{28}$ = 27.98191 U

Mass difference Δm = 2× mass of Al atom – mass of fe atom

= 2×27.98191 – 55.93494

= 0.02888

According to mass energy relation, the energy released $\Delta E = \Delta mc^2$

$= 0.02888 \times (3\times10^8)^2$

$= 0.25992 \times 10^{16}$J

= 0.02888 × 931.5 MeV

[∵ $1u\times c^2 = 931.5$ MeV]

= 26.90172 MeV

SECTION - E

31. (A) Statement of Gauss law

Proof of outward flux due to a point charge Q ,in vacuum within gaussian surface, is independent of its size and shape.

Detailed Answer:

(A) **Gauss' Law:** The electric flux ϕ_E through any closed surface is equal to $\frac{1}{\varepsilon_0}$ times the net charge q enclosed by the surface.

$\phi_E = \oint \vec{E}.d\vec{A} = \frac{q}{\varepsilon_0}$, where ε_0 is permittivity of free space.

The Gauss theorem in electrostatics gives a relation between the electric flux through any closed hypothetical surface and the charge enclosed by the surface.

Proof: Let a point charge +q is placed at O inside a closed surface. Let dA be the small area element surrounding a point P on the surface. Let op = r.

The area element may be represented by a vector $d\vec{A}$ drawn outward along the normal to the elements.

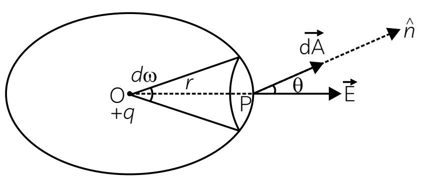
Let electric field intensity at point P be $\vec{E}$ due to charge +q.

The electric flux through the area element dA is,

$$d\phi_E = \vec{E}.d\vec{A} = \varepsilon dA\cos\theta$$

where θ is the angle between the vectors $\vec{E}$ and $d\vec{A}$.

$$d\phi_E = \frac{q}{4\pi\varepsilon_0}\frac{dA}{r^2}\cos\theta$$



Since $\frac{dA\cos\theta}{r^2}$ is the solid angle dω subtended by the area dA at the point O.

∵ $$d\phi_E = \frac{q}{4\pi\varepsilon_0}\,d\omega$$

∴ Total flux through the entire surface

$$\phi_E = \frac{q}{4\pi\varepsilon_0}\oint d\omega$$

$$= \frac{q}{4\pi\varepsilon_0}\times 4\pi$$

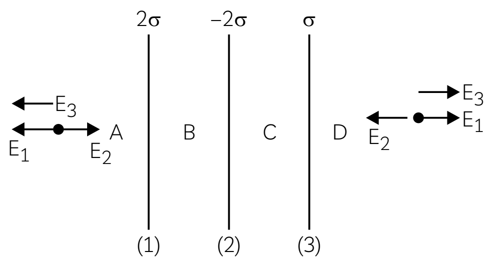
[∵ $\oint d\omega = 4\pi$, the solid angle subtended by the entire closed surface at the point O.

∴ $\phi_E = \frac{q}{\varepsilon_0}$ which is clearly independent of the size and shape of Gaussian surface.

(B) Net electric field towards left = σ/ε left

Net electric field towards right= σ/ε right

Detailed Answer:



Given, thin long sheets have surface charge density +2σ, −2σ and +σ respectively. We need to calculate electric field intensity at point A and point D.

At point A,

Let electric field intensities due to plates (1), (2) and (3) be $\vec{E}_1$, $\vec{E}_2$ and $\vec{E}_3$.

$E_1 = \frac{2\sigma}{2\varepsilon_0}$ (away from sheet 1)

$E_2 = \frac{2\sigma}{2\varepsilon_0}$ (towards sheet 1)

$E_3 = \frac{\sigma}{2\varepsilon_0}$ (away from sheet 1)

Resultant intensity $E_A = E_1 - E_2 + E_3$

$$= \frac{2\sigma}{2\varepsilon_0} - \frac{2\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}$$

$= \frac{\sigma}{2\varepsilon_0}$ (away from sheet 1 or towards left)

At point D

$E_1 = \frac{2\sigma}{2\varepsilon_0}$ (away from sheet 1)

$E_2 = \frac{2\sigma}{2\varepsilon_0}$ (towards sheet 2)

$E_3 = \frac{\sigma}{2\varepsilon_0}$ (away from sheet 3)

Resultant Intensity $E_D = E_1 - E_2 + E_3$

$= \frac{2\sigma}{2\varepsilon_0} - \frac{2\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}$

$= \frac{\sigma}{2\varepsilon_0}$ (away from sheet 3 or towards right)

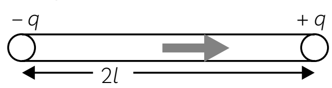
OR

(A) Definition of ideal dipole + example
(B) Derivation of Torque
(C) Putting values in correct formula and solving, value of chargeand potential energy
Q = 8 × 10–3 C
U = –8 J

Detailed Answer:

(A) **Electric dipole :** A pair of equal and opposite point charges placed at a short distance apart is called an electric dipole. The product of one charge and the distance between the charges is called the magnitude of the electric dipole moment p.

Let two charges $-q$ and $+q$ be placed at small distance Say 2l.



The magnitude of electric dipole moment

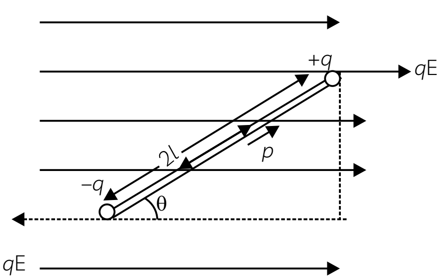
P = q × 2l

P = 2ql

It is a vector quantity whose direction is along the line joining the two charges, pointing from the negative charge to positive charge.

Examples: Molecules like HCl, H_2O etc are electric dipoles. In some molecules one end of the molecule is positively charged and the other end is equally negatively charged. Such molecules are electric dipoles.

(B) Derivation for the calculation of torque on an electric dipole in a uniform electric field:



When an electric dipole is kept in an external uniform electric field, a couple acts on it, which tries to align the dipole in the direction of the field. This is called the restoring couple.

The dipole moment vector $\vec{P}$ making an angle θ with the field $\vec{E}$. Let –q and +q be the charges forming the dipole and 2l is the distance between them. Due to electric field $\vec{E}$, the charge +q experiences a force q$\vec{E}$ (in the direction of the field) and the charge –q experiences an equal and opposite force q$\vec{E}$ (opposite to the field). Since these two forces are equal and opposite, the net transplatory force on the dipole will become zero, so there will be no translatory motion of the dipole in a uniform electric field. But since forces q$\vec{E}$ and –q$\vec{E}$ are acting at different points so these will form a couple, and try to rotate the dipole along the direction of uniform electric field.

The moment of this restoring couple is known as torque.

$\tau = qE\,(2l\sin\theta)$

$= 2ql\,E\sin\theta$

$\tau = pE\sin\theta$ N–m

In vector form,

$\Rightarrow\ \vec{\tau} = \vec{p} \times \vec{E}$

(C) Given, 2l = 2 cm   θ = 60°

$E = 10^5$ N/C $\tau = 8\sqrt{3}$ Nm

q = ?   U = ?

$\tau = pE\sin\theta$

$8\sqrt{3} = 2ql\,E\,\mathrm{Sin}\theta$

$= q \times (2 \times 10^{-2}) \times 10^5\ \mathrm{Sin}60^\circ$

$8\sqrt{3} = 2 \times 10^3 q\ \frac{\sqrt{3}}{2}$

$\Rightarrow\ q = 8 \times 10^{-3}$ C

Potential energy PE = –PE cosθ

$= -\,q \times 2l\,E\cos\theta$

$= -8 \times 10^{-3} \times 2 \times 10^{-3} \times 10^5 \cos 60^\circ$

$= -16 \times \frac{1}{2}$

= –8 J

32. (A) Derivation of instantaneous current

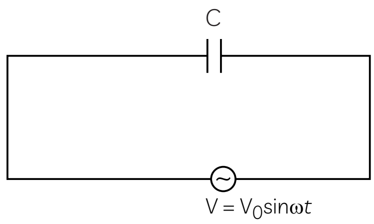
$i = i_0\left(E_{\omega t} + \frac{\pi}{2}\right)$

(B) Reactance : $X_c = \frac{1}{\omega C}$

(C) Phasor diagram showing v and i relation in pure C.

Detailed Answer:

(A)



Let an alternating emf given by $V = V_0$ sinωt be applied across the plates of capacitor having capacitance C. As the emf is alternating, the charge on the capacitor plates varies continuously and correspondingly current flows in the connecting leads. If q be charge on the capacitor plates and i is current at any instant, instantaneous potential difference across the plates of capacitor must be equal to the applied emf.

$\frac{q}{c} = E_0 \sin\omega t$

$\therefore$ Instantaneous current $i = \frac{dq}{dt} = \frac{d}{dt}$ $(E_0 c \sin\omega t)$

$= CE_0 \omega \cos\omega t$

$i = \frac{E_0}{1/\omega C} \sin(\omega t + \pi/2)$

Since maximum value of sin $(\omega t + \pi/2)$ is 1,

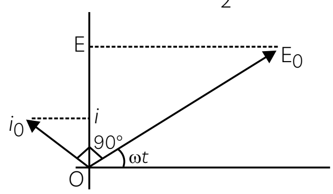
So $i_{max} = \frac{E_0}{1/\omega C}$ ...(i)

$\therefore i = i_0 \sin(\omega t + \frac{\pi}{2})$ ...(ii)

Where $i_0 C = \frac{E_0}{1/\omega C}$ is the peak value of current.

On compairing equation (2) with

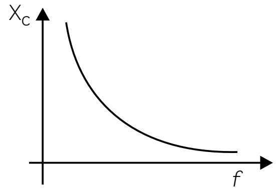
$E = E_0 \sin\omega t$ it is clear that the current leads the emf by a phase angle $\frac{\pi}{2}$



From eq (1) peak value of current $i_0 = \frac{E_0}{1/E\omega c}$

Applying Ohm's law we find that $\frac{1}{\omega c}$ is equivalent to net resistance of the circuit. It represents the effective opposition of the capacitor to the flow of ac. It is known as the reactance of the capacitor or capacitive reactance (x_c).

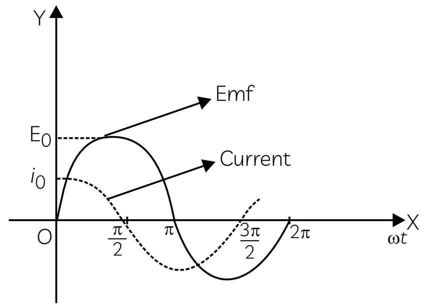
$$X_c = \frac{1}{\omega c} = \frac{1}{2\pi fc}$$

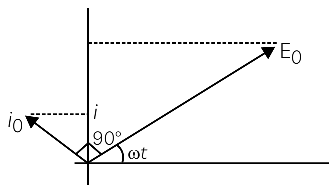


The capacitive reactance decreases with increasing frequency of current as $x_c \propto \frac{1}{f}$. So graph between x_c and f represents a rectangular hyperbola.

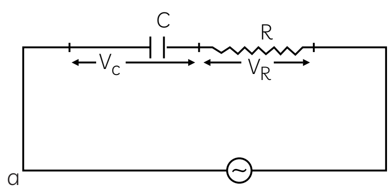
(B) **Phasor Diagram:**

The emf lags behind the current by a phase angle of $\frac{\pi}{2}$ or 90° i.e. When the emf is zero. The current is maximum or vice-versa.





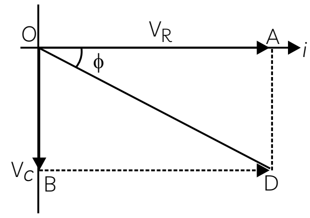
(C)



When a resistance R is added in series with capacitor of capacitance C, the instantaneous potential difference across the capacitor and resistor are given by

$V_c = ix_c$ and $V_R = ix_R$

Now V_R will be in same phase as that of current i while V^e lags behind by 90°.



So resultant applied emf can be calculated as

$E^2 = V_R^2 + V_C^2$

$= i^2 (R^2 + x_c^2)$

$$i = \frac{E}{\sqrt{R^2 + x_c^2}}$$

Here $\sqrt{R^2 + x_c^2}$ represents the effective resistance of the circuit and is called the impedance Z of the circuit.

From phasor diagram,

phase angle $\phi = \frac{V_C}{V_R} = \frac{x_c}{R} = \frac{1/\omega c}{R}$

OR

(a) Principle of ac generator

(b) Well labelled diagram

Brief working and emf expression

(c) reason

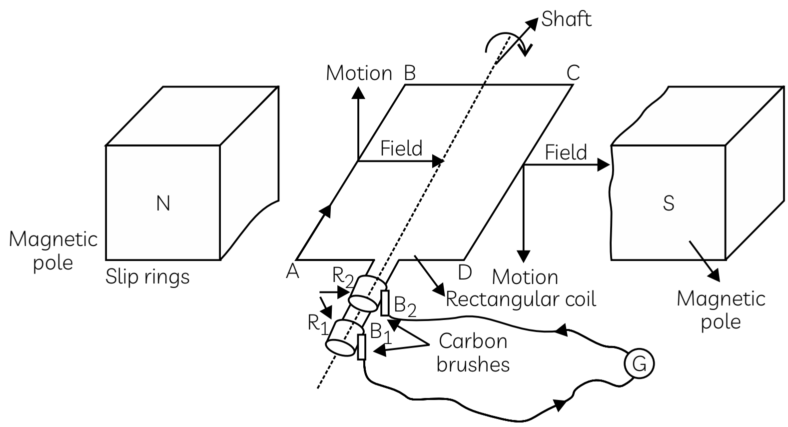
Detailed Answer:

(A) **Principle of ac generator:**

The principle of ac generator is based on electromagnetic induction. When a closed coil is rotated rapidly in a strong magnetic field, the number of magnetic flux-lines (magnetic flux) passing through coil changes continously. Thus an emf is induced in the coil and a current flows in it in a direction given by fleming's right hand rule. In ac generator mechanical energy expanded in rotating the coil appears as electrical energy in the coil.

(B) **Working:**

The schematic diagram for the AC generator is as follows:



In the figure, coil ABCD is placed in the magnetic field. The coil ABCD is horizontal initially. It is made to rotate in the clockwise sense and the arm AB moves up while CD moves down. According to Fleming's right hand rule, the direction of the induced current will be along ABCD. When the coil completes half rotation, the arm CD moves up and AB moves down. Now the direction of the induced current is opposite along DCBA.

The brush B_2 is now positive relative to B, and remains so as long the coil reaches the vertical position again. After this, B_1 is again positive relative to B_2. As a result, an alternating potential difference is developed between B_1 and B_2, generating an alternating current in the circuit.

The magnetic flux linked with a coil is written as:

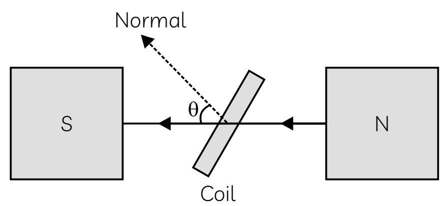
$\phi = BA \cos \theta$

Where θ is the angle between the magnetic field and the area vector of the coil.

$$e = -\frac{d\phi}{dt}$$

$$= BA \sin\theta \ \theta\frac{d\theta}{dt}$$

When a coil is rotated inside the magnetic field, the angle between the area vector and magnetic field changes with time due to which emf is induced. Let A be the area of one true of the coil, N be the number of turns in the coil, $\vec{B}$ be the strength of the magnetic field. Let at some instance the angle between the area vector (direction normal to the coil) of the coil and the magnetic field be θ:

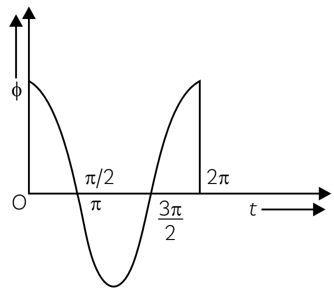


∴ The magnetic flux associated with the given coil in this position is as follows:

$$\phi = N(\vec{B}.\vec{A})$$
$$= NBA \cos \theta$$
$$= NBA \cos \omega t \qquad ...(i)$$

In the above formula, 'ω' is angular velocity of the coil.

The magnetic flux varies with time according to the following figure:

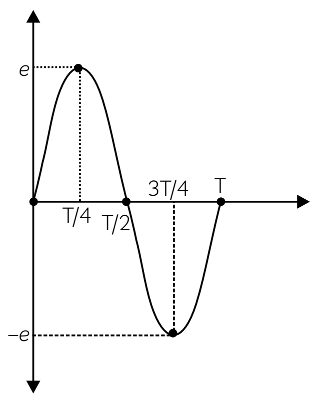


The induced emf is given by:

$$e = -\frac{d\phi}{dt} = -\frac{d}{dt}(NAB \cos\omega t)$$
$$= -NAB \frac{d}{dt}(\cos \omega t)$$
$$= -NAB(-\sin \omega t)\omega$$

$\therefore \quad e = NAB\, \omega \sin \omega t$

The alternating emf varies with the time as follows:



Where is T is time period of AC.

(C) The magnitude of induced emf in a coil rotating in a magnetic field changes continuously with time and is given by

$e = NBA\omega \sin\omega t$

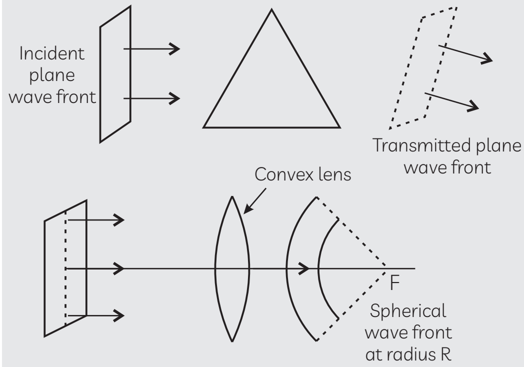
When there is no rotation in the coil, $\omega = 0$

i.e. $e = 0$

It is not possible to generate emf without having rotation in the coil.

33. (a) Definition of weve front

(b) Ray diagram showing shapes of wavefront



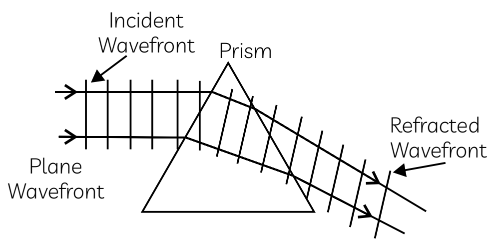
(c) Proof of Snell's law

Detailed Answer:

(A) **Wave front:** If a surface is drawn in a medium such that all the medium particles lying in the surface are in the same phase of oscillation then the surface is called a wavefront.

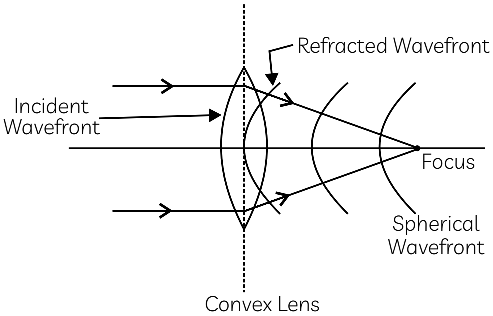
(B) (1) When a plane wavefront hits a thin prism, lower half of the wave meets the glass first and so, this part of the wave is slowed down. This means that the upper part is moving fast and thus the wavefront bends as it enters the prism and so, we get a plane wavefront which is slanted.

Hence, the emerging wavefront is plane wavefront.

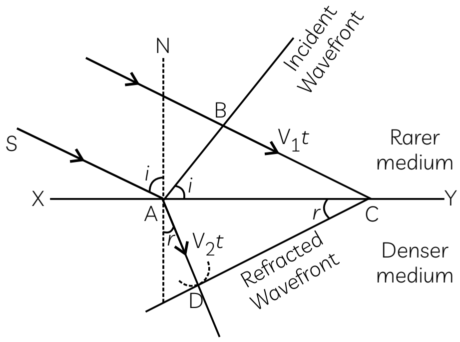


(2) When a plane wavefront hits the lens, it is the centre of the wave that meets the glass first and so this part of the wave is slowed down first (light waves move slower in glass than they do in air). This means that the outer portions of the wave converges. As the wave lean the lens the outer portions move into the air first and so speed up first. This means that the outer portions move off more rapidly first and so the curvature of the wave is further increased so converging the light more strongly.

Hence, the emerging wavefront is spherical wavefront.



(C) **Verification of Snell's Law of refraction using Huygen's formula:**



Let a wavefront AB incident on a plane surface XY, separating two media 1 and 2. Let V_1 and V_2 be the velocities of light in two media such that $v_1 > v_2$.

The wavefront first strikes at point A and then at the successive points towards C. According to Huygen's principle, from each point on AC, the secondary wavelets start growing in the second medium with speed V_2. Let the disturbance takes time t to travel from B to C, then BC = v_1t. During the time the disturbance from B reaches the point C, the secondary wavelets from point A must have spread over a hemisphere of radius AD = v_2t in the second medium. The tangent plane CD drawn from point C over this hemisphere of radius v_2t will be the new refracted wavefront.

Let the angels of incidence and refraction be i and r respectively.

From ΔABC, $\text{Sin}\angle BAC = \text{Sin}\,i = \frac{BC}{AC}$

From ΔADC, $\text{Sin}\angle DCA = \text{Sin}\,r = \frac{AD}{AC}$

$$\Rightarrow \frac{\text{Sin}\,i}{\text{Sin}\,r} = \frac{BC}{AD} = \frac{v_1 t}{v_2 t}$$

$$\Rightarrow \frac{\text{Sin}\,i}{\text{Sin}\,r} = \frac{v_1}{v_2} = {}_1\mu_2 \quad \text{(constant)}$$

This proves Snell's Law of refraction. The constant ${}_1\mu_2$ is called the refractive index of the second medium with respect to first medium.

OR

(A) Choice of objective

(B) Ray diagram of reflecting type telescope Formula of magnifying power

(C) Stating two advantages

Detailed Answer:

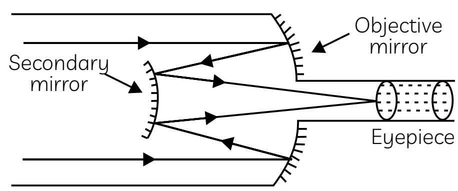
(A) The main considerations with an astronomical telescope are:

(i) Its light gathering power. The light gathering power and hence the brightness of the image is directly proportional to the area of the objective lens.

(ii) The resolving power is the ability to observe two close distant objects distinctly, which also depends on the diameter of the objective lens.

(iii) High magnifying power A telescope having high magnifying power produces apparently a magnified image which enables to see the finer details of the distinct object.(Any two)

(B)



Magnifying Power:

$$m = \frac{f_0}{f_e}$$

(C) Advantages of reflecting telescope over a refracting telescope are:

(1) Reflecting telescope is free from chromatic and spherical aberrations unlike refracting telescope.

Thus image formed is sharp and bright.

(2) It has a larger light gathering power so that a bright image of even far off object is obtained.

(3) Resolving power of reflecting telescope is large.