

SET - 1

Series : SSO/1

कोड नं.

Code No.

55/1/1/D

रोल नं.

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Roll No.

परीक्षार्थी कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।

Candidates must write the Code on the title page of the answer-book.

- कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ 16 हैं ।
- प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए कोड नम्बर को छात्र उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।
- कृपया जाँच कर लें कि इस प्रश्न-पत्र में 26 प्रश्न हैं ।
- कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, प्रश्न का क्रमांक अवश्य लिखें ।
- इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जायेगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
- Please check that this question paper contains 16 printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains 26 questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minutes time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

भौतिक विज्ञान (सैद्धान्तिक)

PHYSICS (Theory)

निर्धारित समय : 3 घंटे]

[अधिकतम अंक : 70

Time allowed : 3 hours]

[Maximum Marks : 70

सामान्य निर्देश :

- (i) इस प्रश्न-पत्र में कुल 26 प्रश्न हैं । सभी प्रश्न अनिवार्य हैं ।
- (ii) इस प्रश्न पत्र के 5 भाग हैं : खण्ड-क, खण्ड-ख, खण्ड-ग, खण्ड-घ और खण्ड-ङ ।
- (iii) खण्ड-क में 5 प्रश्न प्रत्येक 1 अंक का, खण्ड-ख में 5 प्रश्न प्रत्येक 2 अंक के, खण्ड-ग में 12 प्रश्न प्रत्येक 3 अंक के, खण्ड-घ में 4 अंक का एक मूल्याधारित प्रश्न और खण्ड-ङ में 3 प्रश्न प्रत्येक 5 अंक के दिए गए हैं ।
- (iv) समग्र पर कोई विकल्प नहीं है । फिर भी 2 अंक के 1 प्रश्न, 3 अंक के 1 प्रश्न और 5 अंकों के 3 प्रश्नों में भीतरी विकल्प दिए गए हैं । ऐसे प्रश्नों में आपको विकल्पों में से एक को हल करना है ।

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[P.T.O.]



(v) वहाँ आवश्यक हो, वहाँ आप भौतिक अचरों के निम्नलिखित मूल्यों का उपयोग कर सकते हैं :

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

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

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{न्यूट्रॉन का द्रव्यमान} = 1.675 \times 10^{-27} \text{ kg}$$

$$\text{प्रोटोन का द्रव्यमान} = 1.673 \times 10^{-27} \text{ kg}$$

$$\text{ऐवोगेड्रो संख्या} = 6.023 \times 10^{23} \text{ प्रति ग्राम मोल}$$

$$\text{बॉल्ट्ज़मान नियतांक} = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

General Instructions :

- (i) There are **26** questions in **all**. **All** questions are compulsory.
- (ii) This question paper has **five** sections : Section A, Section B, Section C, Section D and Section E.
- (iii) Section A contains **five** questions of **one** mark each, Section B contains **five** questions of **two** marks each, Section C contains **twelve** questions of **three** marks each, Section D contains **one** value based question of **four** marks and Section E contains **three** questions of **five** marks each.
- (iv) There is no overall choice. However, an internal choice has been provided in **one** question of **two** marks, **one** question of **three** marks and all the **three** questions of **five** marks weightage. You have to attempt only **one** of the choices in such questions.
- (v) You may use the following values of physical constants wherever necessary :

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

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

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{mass of neutron} = 1.675 \times 10^{-27} \text{ kg}$$

$$\text{mass of proton} = 1.673 \times 10^{-27} \text{ kg}$$

$$\text{Avogadro's number} = 6.023 \times 10^{23} \text{ per gram mole}$$

$$\text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

खण्ड – क

Section – A

1. संधारित्र - प्रतिघात की परिभाषा लिखिये । इसका एस.आई. (S.I.) मात्रक क्या है ? 1
Define capacitor reactance. Write its S.I. units.
2. 1 cm भुजा के घन (क्यूब) में परिवर्द्ध (बन्द) किसी द्विध्रुव के कारण उससे घन से गुजरने वाले विद्युत फ्लक्स का मान क्या होगा ? 1
What is the electric flux through a cube of side 1 cm which encloses an electric dipole ?
3. किसी उत्तल लेंस के पदार्थ का अपवर्तनांक 1.5 है । इसे 1.65 अपवर्तनांक के किसी माध्यम में डुबाने पर लेंस की प्रकृति कैसी होगी ? 1
A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65.
What is the nature of the lens ?
4. पार्श्व बैंड कैसे उत्पन्न होते हैं ? 1
How are side bands produced ?
5. यहाँ एक पदार्थ, GaAs के लिये, वोल्टता के साथ धारा के परिवर्तन को दर्शाने के लिये एक ग्राफ (आलेख) दिया गया है, उस क्षेत्र की पहचान कीजिये जहाँ,
(i) ऋणात्मक प्रतिरोध है ।
(ii) ओम के नियम का पालन होता है । 1

Graph showing the variation of current versus voltage for a material GaAs is shown in the figure. Identify the region of

- (i) negative resistance
- (ii) where Ohm's law is obeyed.



खण्ड – ख

Section – B

6. एक प्रोटॉन तथा एक एल्फा (α) कण से संबद्ध डी-ब्रॉग्ली तरंगदैर्घ्यों का मान समान है, तो ज्ञात कीजिये –
- (i) उनके त्वरक विभवों का अनुपात
- (ii) उनकी चालों का अनुपात 2

A proton and an α -particle have the same de-Broglie wavelength. Determine the ratio of (i) their accelerating potentials (ii) their speeds.

7. दर्शाइये कि हाइड्रोजन परमाणु की कक्षाओं की त्रिज्या में n^2 के अनुसार परिवर्तन होता है। जहाँ, n परमाणु की क्वांटम संख्या है। 2

Show that the radius of the orbit in hydrogen atom varies as n^2 , where n is the principal quantum number of the atom.

8. नैज तथा अपमिश्रित अर्धचालकों में अन्तर (भेद) कीजिये। 2

Distinguish between 'intrinsic' and 'extrinsic' semiconductors.

9. दर्पण सूत्र के उपयोग द्वारा दर्शाइये कि, किसी अवतल दर्पण के सामने उसकी f (फोकस दूरी) तथा $2f$ (वक्रता त्रिज्या) के बीच स्थित किसी वस्तु का प्रतिबिम्ब, $2f$ के परे ($2f$ से और आगे) बनता है। 2

Use the mirror equation to show that an object placed between f and $2f$ of a concave mirror produces a real image beyond $2f$.

अथवा/OR

दो क्रासित पोलैरॉइडों के बीच में किसी अन्य पोलैरॉइड की शीट (चादर) को घुमाने से पारगमित प्रकाश की तीव्रता के लिये व्यंजक प्राप्त कीजिये।

इस शीट (चादर) की किस स्थिति में पारगमित प्रकाश की तीव्रता अधिकतम होगी ?

Find an expression for intensity of transmitted light when a polaroid sheet is rotated between two crossed polaroids. In which position of the polaroid sheet will the transmitted intensity be maximum ?

10. किरखोप के नियमों के उपयोग से किसी व्हीटस्टोन ब्रिज (सेतु) में संतुलन स्थिति के लिये प्रतिबन्ध (शर्तें) ज्ञात कीजिये। 2

Use Kirchoff's rules to obtain conditions for the balance condition in a Wheatstone bridge.

11. विद्युत चुम्बकीय स्पेक्ट्रम के उस भाग का नाम लिखिये
- (a) जो विमान संचालन में प्रयुक्त रडार व्यवस्था के लिये उपयुक्त होता है ।
 - (b) जिसका उपयोग पेशीय विकृति (तनाव) के उपचार में होता है ।
 - (c) जो चिकित्सा में रोग-निदान के लिये प्रयुक्त होता है ।

संक्षेप में लिखिये कि इन तरंगों को कैसे उत्पन्न किया जा सकता है ।

3

Name the parts of the electromagnetic spectrum which is

- (a) suitable for radar systems used in aircraft navigation.
- (b) used to treat muscular strain.
- (c) used as a diagnostic tool in medicine.

Write in brief, how these waves can be produced.

12. (i) किसी विशाल (बृहत्) अपवर्ती दूरदर्शक के अभिदृश्यक लेंस की फोकस दूरी 15 m है । यदि 1.0 cm फोकस दूरी की नेत्रिका का उपयोग किया जाय तो दूरदर्शक का कोणीय आवर्धन कितना होगा ?
- (ii) यदि इस दूरदर्शक का उपयोग चन्द्रमा को देखने के लिये किया जाय तो, अभिदृश्यक लेंस द्वारा बनाये गये चन्द्रमा के प्रतिबिम्ब का व्यास कितना होगा ? चन्द्रमा का व्यास 3.48×10^6 m तथा इसकी कक्षा की त्रिज्या 3.8×10^8 m है ।

3

- (i) A giant refracting telescope has an objective lens of focal length 15 m. If an eye piece of focal length 1.0 cm is used, what is the angular magnification of the telescope ?
- (ii) If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens ? The diameter of the moon is 3.48×10^6 m and the radius of lunar orbit is 3.8×10^8 m.



13. आइन्स्टाइन के प्रकाश विद्युत समीकरण को लिखिये । उल्लेख कीजिये कि इसकी सहायता से प्रकाश विद्युत प्रभाव के किन महत्वपूर्ण लक्षणों की व्याख्या की जा सकती है ।

किसी पृष्ठ (सतह) पर आपतित प्रकाश की तरंगदैर्घ्य में λ_1 से λ_2 तक परिवर्तन होने से प्रकाश विद्युत इलेक्ट्रॉनों की अधिकतम गतिज ऊर्जा दो गुना हो जाती है ।

तो, धातु पृष्ठ की देहली तरंगदैर्घ्य λ_0 तथा कार्यफलन के लिये व्यंजक व्युत्पन्न कीजिये ।

3

Write Einstein's photoelectric equation and mention which important features in photoelectric effect can be explained with the help of this equation.

The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from λ_1 to λ_2 . Derive the expressions for the threshold wavelength λ_0 and work function for the metal surface.

14. एल्फा (α) किरणों के सोने की पत्ती द्वारा प्रकीर्णन सम्बन्धी गाइगर-मार्सडन प्रयोग के अध्ययन में, लक्ष्य-नाभिक के कूलॉम क्षेत्र में एल्फा (α) कणों के प्रक्षेप-पथ को दर्शाइये । संक्षेप में स्पष्ट कीजिये कि इस अध्ययन से नाभिक के साइज़ के बारे में सूचना कैसे मिलती है ।

संबंध, $R = R_0 A^{1/3}$ से दर्शाइये कि, नाभिकीय पदार्थ घनत्व A पर निर्भर नहीं करता । (यहाँ R_0 एक स्थिरांक है तथा A नाभिक की द्रव्यमान संख्या है ।)

3

In the study of Geiger-Marsdon experiment on scattering of α particles by a thin foil of gold, draw the trajectory of α -particles in the coulomb field of target nucleus. Explain briefly how one gets the information on the size of the nucleus from this study.

From the relation $R = R_0 A^{1/3}$, where R_0 is constant and A is the mass number of the nucleus, show that nuclear matter density is independent of A.

अथवा/OR

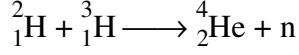
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नाभिकीय विखंडन तथा नाभिकीय संलयन में भेद (अन्तर) लिखिये । दर्शाइये कि इन दोनों प्रक्रमों में ऊर्जा कैसे मोचित होती (निकलती) है ।

यहाँ दर्शाई गई ड्यूटेरियम-ट्राइटियम संलयन अभिक्रिया में मोचित ऊर्जा का मान MeV में परिकलित कीजिये :



दिया है, द्रव्यमान :

$$m({}^2_1\text{H}) = 2.014102 \text{ u}$$

$$m({}^3_1\text{H}) = 3.016049 \text{ u}$$

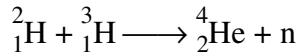
$$m({}^4_2\text{He}) = 4.002603 \text{ u}$$

$$m_{\text{n}} = 1.008665 \text{ u}$$

$$1\text{u} = 931.5 \text{ MeV}/c^2$$

Distinguish between nuclear fission and fusion. Show how in both these processes energy is released.

Calculate the energy release in MeV in the deuterium-tritium fusion reaction :



Using the data :

$$m({}^2_1\text{H}) = 2.014102 \text{ u}$$

$$m({}^3_1\text{H}) = 3.016049 \text{ u}$$

$$m({}^4_2\text{He}) = 4.002603 \text{ u}$$

$$m_{\text{n}} = 1.008665 \text{ u}$$

$$1\text{u} = 931.5 \text{ MeV}/c^2$$

15. आयाम मॉडुलित (AM) संकेतों के लिए एक संसूचक का एक ब्लॉक आरेख बनाइये । आवश्यक प्रक्रमों तथा तरंगरूपों के उपयोग द्वारा दर्शाइये कि निवेशी आयाम मॉडुलित (AM) तरंग से मूल संदेश संकेत का संसूचन कैसे होता है ।

3

Draw a block diagram of a detector for AM signal and show, using necessary processes and the waveforms, how the original message signal is detected from the input AM wave.

16. एक सेल का विद्युत वाहक बल (ई.एम.एफ.) 'E' है और इसका आंतरिक प्रतिरोध 'r' है । इसे 'R' लोड प्रतिरोध के सिरों से जोड़ा गया है । टर्मिनल वोल्टता V तथा (i) R और (ii) धारा I के बीच ग्राफ बनाइये ।

यह पाया जाता है कि जब $R = 4 \Omega$ है तो विद्युत धारा का मान 1 A है और R का मान बढ़ाकर 9Ω कर देने से धारा का मान कम होकर 0.5 A रह जाता है । इससे विद्युत वाहक बल (ई.एम.एफ.) E तथा आंतरिक प्रतिरोध r का मान ज्ञात कीजिये ।

3

A cell of emf 'E' and internal resistance 'r' is connected across a variable load resistor R. Draw the plots of the terminal voltage V versus (i) R and (ii) the current I.

It is found that when $R = 4 \Omega$, the current is 1 A and when R is increased to 9Ω , the current reduces to 0.5 A. Find the values of the emf E and internal resistance r.

17. अज्ञात धारिता के दो संधारित्रों C_1 तथा C_2 को पहले श्रेणीक्रम में और फिर समान्तर पार्श्वक्रम में जोड़ा जाता है । इन संयोजनों को एक-एक कर 100 V की बैटरी के सिरों से जोड़ा जाता है । यदि इन दो संयोजनों में संचित ऊर्जा क्रमशः 0.045 J तथा 0.25 J हो, तो C_1 तथा C_2 का मान ज्ञात कीजिये । समान्तर (पार्श्व) क्रम में प्रत्येक संधारित्र पर आवेश के मान का परिकलन भी कीजिये ।

3

Two capacitors of unknown capacitances C_1 and C_2 are connected first in series and then in parallel across a battery of 100 V. If the energy stored in the two combinations is 0.045 J and 0.25 J respectively, determine the value of C_1 and C_2 . Also calculate the charge on each capacitor in parallel combination.

18. गैल्वेनोमीटर की कार्यप्रणाली के सिद्धान्त का वर्णन कीजिये ।

एक गैल्वेनोमीटर का प्रतिरोध G है । इसके श्रेणीक्रम में एक प्रतिरोध R_1 जोड़कर इसे V वोल्ट परास के वोल्टमीटर में रूपान्तरित किया जाता है । यदि गैल्वेनोमीटर के साथ श्रेणीक्रम में R_2 प्रतिरोध जोड़ा जाय तो वोल्टमीटर $V/2$ वोल्ट तक माप सकता है । R_1 तथा R_2 के पदों में वह प्रतिरोध ज्ञात कीजिये, जो इस गैल्वेनोमीटर को $2V$ परास के वोल्टमीटर में रूपान्तरित कर सके । R_1 तथा R_2 के पदों में गैल्वेनोमीटर के प्रतिरोध 'G' का मान भी ज्ञात कीजिये ।

3

State the principle of working of a galvanometer.

A galvanometer of resistance G is converted into a voltmeter to measure upto V volts by connecting a resistance R_1 in series with the coil. If a resistance R_2 is connected in series with it, then it can measure upto $V/2$ volts. Find the resistance, in terms of R_1 and R_2 , required to be connected to convert it into a voltmeter that can read upto $2V$. Also find the resistance G of the galvanometer in terms of R_1 and R_2 .

19. फोटोडायोडों की संरचना किन प्रतिफलों को ध्यान में रखकर की जाती है ? एक उपयुक्त आरेख की सहायता से इसकी कार्यविधि का वर्णन कीजिये ।

यद्यपि पश्चदिशिक बायस की धारा की तुलना में अग्रदिशिक बायस की धारा अधिक होती है, फिर भी फोटोडायोड को पश्चदिशिक बायस में प्रचालित करने का कारण क्या है ?

3

With what considerations in view, a photodiode is fabricated ? State its working with the help of a suitable diagram.

Eventhough the current in the forward bias is known to be more than in the reverse bias, yet the photodiode works in reverse bias. What is the reason ?

20. उभयनिष्ठ उत्सर्जक (CE) विन्यास में ट्रांजिस्टर प्रवर्धक का एक परिपथ आरेख बनाइये ।

(i) निवेशी प्रतिरोध तथा (ii) धारा प्रवर्धक गुणांक को परिभाषित कीजिये । प्ररूपी निवेश तथा निर्गत अभिलाक्षणिकों के उपयोग द्वारा इनका मान कैसे निर्धारित किया जाता है ?

3

Draw a circuit diagram of a transistor amplifier in CE configuration.

Define the terms : (i) Input resistance and (ii) Current amplification factor. How are these determined using typical input and output characteristics ?

21. निम्नांकित प्रश्नों का उत्तर लिखिये :

- (a) किसी द्विझिरी प्रयोग में प्रयुक्त प्रकाश की तरंगदैर्घ्य 600 nm है, दूरस्थित किसी पर्दे पर बनी फ्रिंजों की कोणीय चौड़ाई 0.1° है। तो, दो झिरियों के बीच अन्तराल (दूरी) ज्ञात कीजिये।
- (b) वायु में संचरण करती हुए 5000 Å तरंगदैर्घ्य का प्रकाश जल के पृष्ठ से अंशतः परावर्तित होता है। इससे परावर्तित तथा अपवर्तित प्रकाश की तरंगदैर्घ्य तथा आवृत्ति पर क्या प्रभाव पड़ेगा ?

3

Answer the following questions :

- (a) In a double slit experiment using light of wavelength 600 nm, the angular width of the fringe formed on a distant screen is 0.1° . Find the spacing between the two slits.
- (b) Light of wavelength 5000 Å propagating in air gets partly reflected from the surface of water. How will the wavelengths and frequencies of the reflected and refracted light be affected ?

22. X_L प्रेरकत्व के एक प्रेरक को एक बल्ब B तथा एक ए.सी. (ac) स्रोत से श्रेणीक्रम में जोड़ा गया है। बल्ब की दीप्ति (चमक) पर क्या प्रभाव पड़ेगा यदि, (i) प्रेरक में फेरों की संख्या को कम कर दिया जाय ? (ii) प्रेरक के भीतर लोहे की एक छड़ डाल दी जाय ? (iii) इस परिपथ से श्रेणीक्रम में $X_C = X_L$ प्रतिघात का संधारित्र जोड़ दिया जाय ?

प्रत्येक दशा में अपने उत्तर की पुष्टि के लिये कारण लिखिये।

3

An inductor L of inductance X_L is connected in series with a bulb B and an ac source. How would brightness of the bulb change when (i) number of turn in the inductor is reduced, (ii) an iron rod is inserted in the inductor and (iii) a capacitor of reactance $X_C = X_L$ is inserted in series in the circuit. Justify your answer in each case.



Section – D

23. अपने विद्यालय से आते हुए कुछ विद्यार्थियों ने रास्ते में एक विद्युत सब स्टेशन पर एक बॉक्स (बक्सा) लगा देखा जिस पर लिखा था “खतरा H.T. 2200 V” । वे इतनी उच्च वोल्टता की उपयोगिता को समझ नहीं पाये जबकि उनके घरों में विद्युत सप्लाई की वोल्टता केवल 220 V होती है । उन्होंने अगले दिन यही प्रश्न अपने शिक्षक से पूछा । शिक्षक ने इसे एक महत्वपूर्ण प्रश्न मानते हुए इसे पूरी कक्षा को समझाया ।

निम्नांकित प्रश्नों के उत्तर लिखिये :

- (i) a.c. (ए.सी.) विद्युतधारा की विभवता को कम करने के लिये किस युक्ति का उपयोग किया जाता है और यह युक्ति किस सिद्धान्त पर कार्य करती है ?
- (ii) क्या इस युक्ति का उपयोग, उच्च वोल्टता डी.सी. (dc) की वोल्टता को कम करने में किया जा सकता है ? स्पष्ट कीजिये ।
- (iii) शिक्षक तथा विद्यार्थियों द्वारा प्रदर्शित मूल्यों का उल्लेख कीजिये ।

4

A group of students while coming from the school noticed a box marked “Danger H.T. 2200 V” at a substation in the main street. They did not understand the utility of a such a high voltage, while they argued, the supply was only 220 V. They asked their teacher this question the next day. The teacher thought it to be an important question and therefore explained to the whole class.

Answer the following questions :

- (i) What device is used to bring the high voltage down to low voltage of a.c. current and what is the principle of its working ?
- (ii) Is it possible to use this device for bringing down the high dc voltage to the low voltage ? Explain.
- (iii) Write the values displayed by the students and the teacher.



खण्ड – ड

Section – E

24. (a) एम्पियर के परिपथीय नियम को लिखिये । इस नियम के उपयोग से, वायु कोड वाले किसी टेरॉइड के भीतर चुम्बकीय क्षेत्र के लिये व्यंजक प्राप्त कीजिये, यदि इस टेरॉइड की औसत त्रिज्या 'r' है, इसकी प्रति इकाई लम्बाई में फेरों की संख्या 'n' है तथा इससे एक स्थिर (अपरिवर्ती) धारा 'I' प्रवाहित हो रही है ।
- (b) एक परिनालिका में फेरों की संख्या 'N' है, तथा इसकी अनुप्रस्थ काट का क्षेत्रफल 'A' है । इसके बाईं ओर स्थित एक प्रेक्षक पाता है कि, इससे एक अपरिवर्ती (अचर) धारा 'I' दक्षिणावर्त दिशा में प्रवाहित हो रही है । इस परिनालिका के कारण चुंबकीय क्षेत्र रेखाओं का चित्रण कीजिये तथा परिनालिका की ध्रुवता का विशेष रूप से उल्लेख कीजिये । दर्शाइये कि यह परिनालिका एक छड़ (दंड) चुम्बक की भाँति व्यवहार करती है जिसका चुम्बकीय आघूर्ण, $m = NIA$.

5

- (a) State Ampere's circuital law. Use this law to obtain the expression for the magnetic field inside an air cored toroid of average radius 'r', having 'n' turns per unit length and carrying a steady current I.
- (b) An observer to the left of a solenoid of N turns each of cross section area 'A' observes that a steady current I in it flows in the clockwise direction. Depict the magnetic field lines due to the solenoid specifying its polarity and show that it acts as a bar magnet of magnetic moment $m = NIA$.

अथवा/OR

55/1/1/D

12



- (a) 'अन्योन्य-प्रेरकत्व' (mutual inductance) को परिभाषित कीजिये तथा इसका S.I. (एस.आई.) मात्रक लिखिये ।
- (b) एक लम्बी परिनालिका के ऊपर तार लपेट कर एक और परिनालिका बनाई गई है । इससे बनी समान (एक ही) लम्बाई की दो समाक्षी परिनालिकाओं के अन्योन्य प्रेरकत्व के लिये एक व्यंजक प्राप्त कीजिये ।
- (c) एक प्रयोग में दो कुंडलियों c_1 तथा c_2 को एक दूसरे के पास रखा गया है । कुंडली c_2 में प्रवाहित विद्युत धारा के परिवर्तन से c_1 में प्रेरित विद्युत वाहक बल (ई.एम.एफ.) के लिये एक व्यंजक प्राप्त कीजिये ।

5

- (a) Define mutual inductance and write its S.I. units.
- (b) Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound one over the other.
- (c) In an experiment, two coils c_1 and c_2 are placed close to each other. Find out the expression for the emf induced in the coil c_1 due to a change in the current through the coil c_2 .

25. (a) द्वितीयक तरंगिकाओं के लिये हाइगेंस की संरचना के उपयोग द्वारा स्पष्ट कीजिये कि, किसी पतली झिरी पर एकवर्णी प्रकाश के लम्बवत् आपतित होने से, पर्दे पर विवर्तन पैटर्न कैसे बनता है ।
- (b) दर्शाइये कि प्रथम विवर्तन फ्रिंज की कोणीय चौड़ाई, केन्द्रीय फ्रिंज की चौड़ाई की आधी होती है ।
- (c) स्पष्ट कीजिये कि n के मान में वृद्धि होने से, $\theta = \left(n + \frac{1}{2}\right) \frac{\lambda}{a}$ पर प्राप्त उच्चष्ट, क्षीण क्यों होते जाते हैं ।

5

- (a) Using Huygens's construction of secondary wavelets explain how a diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally.
- (b) Show that the angular width of the first diffraction fringe is half that of the central fringe.
- (c) Explain why the maxima at $\theta = \left(n + \frac{1}{2}\right) \frac{\lambda}{a}$ become weaker and weaker with increasing n .

अथवा/OR

55/1/1/D

13

[P.T.O.]



(a) जैसा कि यहाँ आरेख में दर्शाया गया है, एक गोलीय उत्तलपृष्ठ की वक्रता त्रिज्या R है। इसके एक ओर के माध्यम का अपवर्तनांक n_1 है और दूसरी ओर के माध्यम का अपवर्तनांक n_2 है। इस उत्तल पृष्ठ के सामने n_1 अपवर्तनांक के माध्यम में एक बिन्दु बिम्ब (वस्तु) 'O' रखी है। इसके प्रतिबिम्ब का बनना दर्शाने के लिये एक किरण आरेख बनाइये और n_1 , n_2 तथा R के पदों में वस्तु की दूरी तथा प्रतिबिम्ब की दूरी के बीच संबंध व्युत्पन्न कीजिये।

(b) जब n_2 अपवर्तनांक के माध्यम में ऊपर बना प्रतिबिम्ब किसी ऐसे अवतल पृष्ठ के लिये आभासी वस्तु का कार्य करता है, जिसकी दूसरी ओर के माध्यम का अपवर्तनांक n_1 है ($n_2 > n_1$) तो, इस पृष्ठ के लिये भी समरूप (भाग (a) के समान) समीकरण लिखिये। इससे 'लेन्स-मेकर सूत्र' के लिये व्यंजक प्राप्त कीजिये।

5

(a) A point object 'O' is kept in a medium of refractive index n_1 in front of a convex spherical surface of radius of curvature R which separates the second medium of refractive index n_2 from the first one, as shown in the figure.

Draw the ray diagram showing the image formation and deduce the relationship between the object distance and the image distance in terms of n_1 , n_2 and R .

(b) When the image formed above acts as a virtual object for a concave spherical surface separating the medium n_2 from n_1 ($n_2 > n_1$), draw this ray diagram and write the similar (similar to (a)) relation. Hence obtain the expression for the lens maker's formula.

26. (a) एक द्विध्रुव के दो बिन्दु आवेशों $+q$ तथा $-q$ से बना है जिनके बीच की दूरी $2a$ है। इस द्विध्रुव का द्विध्रुव आघूर्ण \vec{p} है। इस द्विध्रुव के कारण, इसकी अक्षीय सरल रेखा पर तथा इसके केन्द्र से x दूरी पर विद्युत क्षेत्र \vec{E} के लिये एक व्यंजक, \vec{p} के पदों में प्राप्त कीजिये। अतः दर्शाइये कि, $x \gg a$ की स्थिति में $\vec{E} \longrightarrow 2\vec{p}/(4\pi \epsilon_0 x^3)$.
- (b) दिया है कि किसी स्थान पर विद्युत क्षेत्र $\vec{E} = 2xi$, तो इस घन (क्यूब) से होकर गुजरने वाले नेट विद्युत फ्लक्स का तथा इसमें परिवद्ध (बन्द) आवेश का मान ज्ञात कीजिये।

5

- (a) An electric dipole of dipole moment \vec{p} consists of point charges $+q$ and $-q$ separated by a distance $2a$ apart. Deduce the expression for the electric field \vec{E} due to the dipole at a distance x from the centre of the dipole on its axial line in terms of the dipole moment \vec{p} . Hence show that in the limit $x \gg a$, $\vec{E} \longrightarrow 2\vec{p}/(4\pi \epsilon_0 x^3)$.
- (b) Given the electric field in the region $\vec{E} = 2xi$, find the net electric flux through the cube and the charge enclosed by it.

अथवा/OR

- (a) उपयुक्त आरेखों के उपयोग द्वारा बाह्य विद्युत क्षेत्र की उपस्थिति में किसी (i) चालक तथा (ii) परावैद्युत पदार्थ के व्यवहार में अन्तर को स्पष्ट कीजिये। किसी परावैद्युत पदार्थ के ध्रुवीकरण को परिभाषित कीजिये तथा सुग्राहिता (वैद्युत प्रवृत्ति) से इसका संबंध लिखिये।

55/1/1/D

15

[P.T.O.]



- (b) एक पतले धात्विक गोलीय कोश (खोल) की त्रिज्या R है और इसके पृष्ठ पर Q आवेश है। इसके केन्द्र C पर एक बिन्दु आवेश $\frac{Q}{2}$ रखा है। एक अन्य आवेश $+2Q$, इस कोश के बाहर, इसके केन्द्र से x दूरी पर यहाँ दर्शाये गये अनुसार रखा है। ज्ञात कीजिये : (i) कोश के केन्द्र पर तथा A बिन्दु पर स्थित आवेश पर बल (ii) कोश से होकर जाने वाला विद्युत फ्लक्स।

5

- (a) Explain, using suitable diagrams, the difference in the behaviour of a (i) conductor and (ii) dielectric in the presence of external electric field. Define the terms polarization of a dielectric and write its relation with susceptibility.
- (b) A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at its centre C and an other charge $+2Q$ is placed outside the shell at a distance x from the centre as shown in the figure. Find (i) the force on the charge at the centre of shell and at the point A , (ii) the electric flux through the shell.

MARKING SCHEME

Q. No.	Expected Answer / Value Points	Marks	Total Marks				
Set1 Q1 Set2 Q5 Set3 Q4	It is defined as the opposition to the flow of current in ac circuits offered by a capacitor. <u>Alternatively:</u> $X_c = \frac{1}{\omega C}$ S.I Unit : ohm	½ ½	1				
Set1 Q2 Set2 Q1 Set3 Q5	Zero	1	1				
Set1 Q3 Set2 Q2 Set3 Q1	Converging (Convex Lens),(Also accept if a student writes it as a diverging Lens or Concave lens (Since hindi translation does not match with English version)	1	1				
Set1 Q4 Set2 Q3 Set3 Q2	Side bands are produced due to the superposition of carrier waves of frequency ω_c over modulating / audio signal of frequency ω_m . <u>Alternatively:</u> (Credit may be given if a student mentions the side bands as $\omega_c \pm \omega_m$)	1	1				
Set1 Q5 Set2 Q4 Set3 Q3	DE : Negative resistance region AB : Where Ohm's law is obeyed.(Also accept BC)	½ ½	1				
Set1 Q6 Set2 Q10 Set3 Q9	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Determination of ratio (i) accelerating potential</td> <td style="text-align: right; padding: 5px;">1</td> </tr> <tr> <td style="padding: 5px;">(ii) speed</td> <td style="text-align: right; padding: 5px;">1</td> </tr> </table> (i) $\lambda = \frac{h}{\sqrt{2mqV}} \Rightarrow V = \frac{h^2}{2mq\lambda^2}$ $m_\alpha = 4m_p, q_\alpha = 2q_p$ $\Rightarrow \frac{V_p}{V_\alpha} = \frac{m_\alpha q_\alpha}{m_p q_p}$ $= \frac{4m_p \times 2q_p}{m_p q_p}$ $= 8 : 1$	Determination of ratio (i) accelerating potential	1	(ii) speed	1	½ ½	
Determination of ratio (i) accelerating potential	1						
(ii) speed	1						



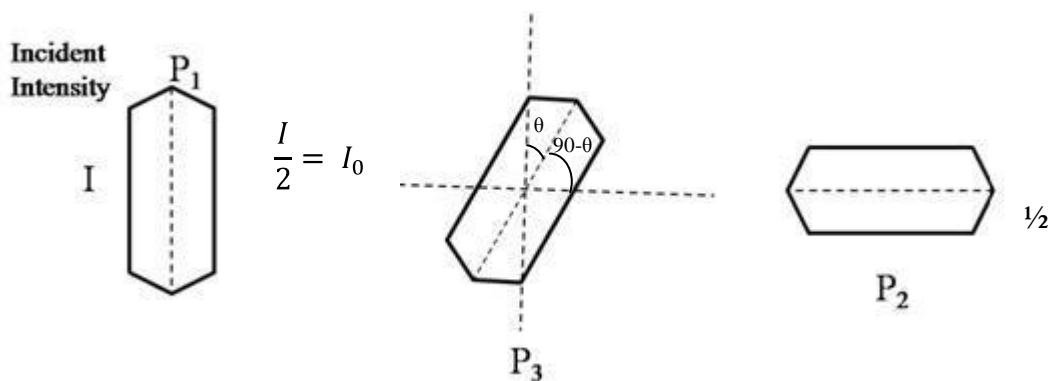
	$(ii) \quad \lambda = \frac{h}{mv} \Rightarrow v = \frac{h}{m\lambda}$ $\Rightarrow \frac{V_p}{V_\alpha} = \frac{m_\alpha}{m_p} = 4$	1/2							
		1/2	2						
Set1 Q7 Set2 Q6 Set3 Q10	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> Showing that the radius of orbit varies as n^2 2 </div> $\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0} \frac{e^2}{r^2}$ <p>Or $mv^2r = \frac{1}{4\pi\epsilon_0} e^2 \dots\dots\dots(i)$</p> $mvr = \frac{nh}{2\pi}$ $m^2v^2r^2 = \frac{n^2h^2}{4\pi^2} \dots\dots\dots(ii)$ <p>Divide (ii) by (i)</p> $mr = \frac{n^2h^2}{4\pi^2} \times \frac{4\pi\epsilon_0}{e^2}$ $\therefore r = \frac{n^2h^2}{4\pi^2me^2} \cdot 4\pi\epsilon_0$ $\therefore r \propto n^2$ <p>(Give full credit to any other correct alternative method)</p>	1/2 1/2 1/2 1/2	2						
Set1 Q8 Set2 Q7 Set3 Q6	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> Distinction between intrinsic & extrinsic semiconductor 2 </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%; padding: 5px;">Intrinsic Semiconductor</th> <th style="width: 50%; padding: 5px;">Extrinsic Semiconductor</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">(i) Without any impurity atoms.</td> <td style="padding: 5px;">(i) Doped with trivalent/ pentavalent impurity atoms.</td> </tr> <tr> <td style="padding: 5px;">(ii) $n_e = n_h$</td> <td style="padding: 5px;">(ii) $n_e \neq n_h$</td> </tr> </tbody> </table> <p>(Any other correct distinguishing features.)</p>	Intrinsic Semiconductor	Extrinsic Semiconductor	(i) Without any impurity atoms.	(i) Doped with trivalent/ pentavalent impurity atoms.	(ii) $n_e = n_h$	(ii) $n_e \neq n_h$	1 1	2
Intrinsic Semiconductor	Extrinsic Semiconductor								
(i) Without any impurity atoms.	(i) Doped with trivalent/ pentavalent impurity atoms.								
(ii) $n_e = n_h$	(ii) $n_e \neq n_h$								
Set1 Q9 Set2 Q8 Set3 Q7	<div style="border: 1px solid black; padding: 5px;"> Derivation of the required condition 2 </div>								

	<p>$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$</p> <p>For concave mirror $f < 0$ and $u < 0$ As object lies between f and $2f$</p> <p>(i) At $u = -f$</p> $\frac{1}{v} = -\frac{1}{f} + \frac{1}{f}$ <p>$\Rightarrow v = \infty$</p> <p>At $u = -2f$</p> $\Rightarrow \frac{1}{v} = -\frac{1}{f} + \frac{1}{2f} = -\frac{1}{2f}$ <p>$\Rightarrow v = -2f$</p> <p>\Rightarrow Hence, image distance $v \geq -2f$</p> <p>Since v is negative therefore the image is real.</p> <p>Alternative Method</p> $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ <p>For Concave mirror $f < 0, u < 0$</p> <p>$\therefore 2f < u < f$</p> $\Rightarrow \frac{1}{2f} > \frac{1}{u} > \frac{1}{f}$ $\frac{1}{2f} - \frac{1}{f} > \frac{1}{u} - \frac{1}{f} > \frac{1}{f} - \frac{1}{f}$ $\Rightarrow -\frac{1}{2f} - \frac{1}{v} > 0 \quad \because \frac{1}{u} - \frac{1}{f} = \frac{1}{-v}$ $\Rightarrow \frac{1}{2f} < \frac{1}{v} < 0$ <p>$\Rightarrow v < 0 \quad \therefore$ image is real</p> <p>Also $v > 2f$ image is formed beyond $2f$. (Any alternative correct method should be given full credit.)</p>	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p>	<p></p> <p>2</p> <p></p> <p>2</p>
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OR

Finding the expression for intensity	1 ½
Position of polaroid sheet for maximum intensity	½

Let the rotating Polaroid sheet makes an angle θ with the first Polaroid
 \therefore angle with the other Polaroid will be $(90 - \theta)$



Applying Malus's law between P_1 and P_3

$$I' = I_0 \cos^2 \theta$$

Between P_3 and P_2

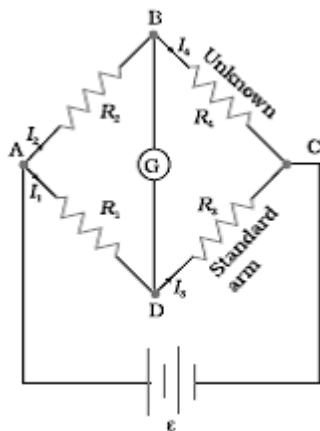
$$I'' = (I_0 \cos^2 \theta) \cos^2 (90 - \theta)$$

$$I'' = \frac{I_0}{4} \cdot \sin^2 2\theta$$

\therefore Transmitted intensity will be maximum when $\theta = \frac{\pi}{4}$

Set1 Q10
 Set2 Q9
 Set3 Q8

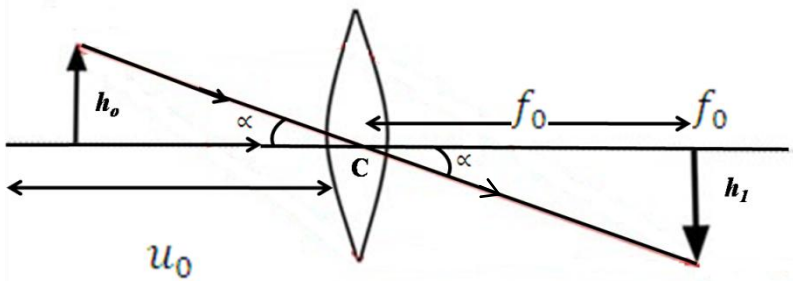
Obtaining condition for the balance Wheatstone bridge	2
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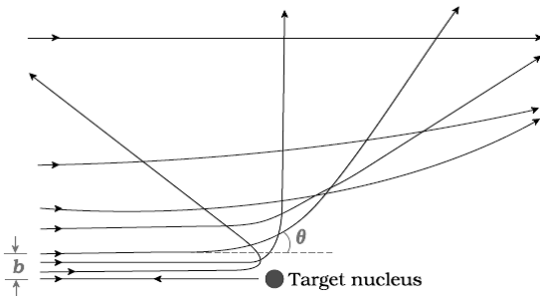


Applying Kirchoff's loop rule to closed loop ADBA

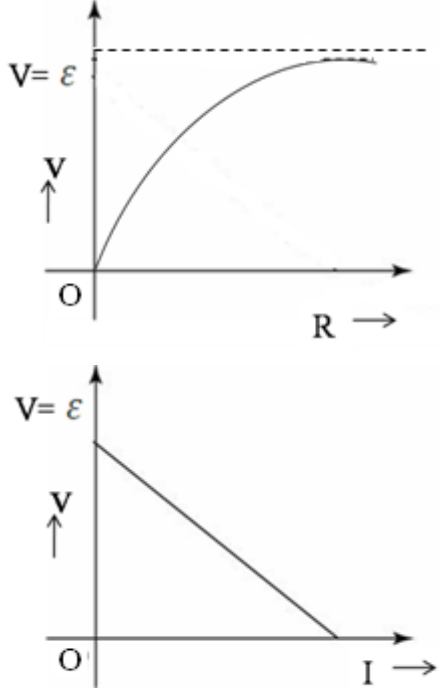
$$-I_1 R_1 + 0 + I_2 R_2 = 0 \quad (I_g = 0) \quad \dots(i)$$

	<p>For loop CBDC $-I_2R_4 + 0 + I_1R_3 = 0$(ii)</p> <p>=> from equation (i)</p> $\frac{I_1}{I_2} = \frac{R_1}{R_2}$ <p>From equation (ii)</p> $\frac{I_1}{I_2} = \frac{R_4}{R_3}$ $\therefore \frac{R_1}{R_2} = \frac{R_4}{R_3}$	<p>1/2</p> <p>1/2</p>	<p>2</p>				
<p>Set1 Q11 Set2 Q19 Set3 Q16</p>	<table border="1" style="width: 100%;"> <tr> <td style="width: 60%;">Name of the parts of e.m. spectrum for a,b,c</td> <td style="width: 40%;">1/2+ 1/2 + 1/2</td> </tr> <tr> <td>Production</td> <td>1/2+ 1/2 + 1/2</td> </tr> </table> <p>(a) Microwave Production : Klystron/magnetron/Gunn diode (any one)</p> <p>(b) Infrared Radiation Production : Hot bodies / vibrations of atoms and molecules (any one)</p> <p>(c) X-Rays Production : Bombarding high energy electrons on metal target/ x-ray tube/inner shell electrons(any one).</p>	Name of the parts of e.m. spectrum for a,b,c	1/2+ 1/2 + 1/2	Production	1/2+ 1/2 + 1/2	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>3</p>
Name of the parts of e.m. spectrum for a,b,c	1/2+ 1/2 + 1/2						
Production	1/2+ 1/2 + 1/2						
<p>Set1 Q12 Set2 Q20 Set3 Q17</p>	<table border="1" style="width: 100%;"> <tr> <td style="width: 60%;">(i) Calculation of angular magnification</td> <td style="width: 40%;">1 1/2</td> </tr> <tr> <td>(ii) Calculation of image of diameter of Moon</td> <td>1 1/2</td> </tr> </table> <p>Angular Magnification</p> $m = \frac{f_o}{f_e}$ $= \frac{15}{10^{-2}} = 1500$	(i) Calculation of angular magnification	1 1/2	(ii) Calculation of image of diameter of Moon	1 1/2	<p>1</p> <p>1/2</p>	
(i) Calculation of angular magnification	1 1/2						
(ii) Calculation of image of diameter of Moon	1 1/2						

	 <p>Angular size of the moon = $\left(\frac{3.48 \times 10^6}{3.8 \times 10^8}\right) = \frac{3.48}{3.8} \times 10^{-2}$ radian \therefore Angular size of the image = $\left(\frac{3.48}{3.8} \times 10^{-2} \times 1500\right) =$ radian</p> <p>Diameter of the image = $\frac{3.48}{3.8} \times 15 \times \text{focal length of eye piece}$ $= \frac{3.48}{3.8} \times 15 \times 1\text{cm}$ $= 13.7\text{cm}$</p> <p>(Also accept alternative correct method.)</p>	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>3</p>										
<p>Set1 Q13 Set2 Q21 Set3 Q18</p>	<table border="1" data-bbox="266 924 1247 1054"> <tr> <td>(i)</td> <td>Einstein's Photoelectric equation</td> <td>1/2</td> </tr> <tr> <td>(ii)</td> <td>Important features</td> <td>1/2 + 1/2</td> </tr> <tr> <td>(iii)</td> <td>Derivation of expressions for λ_0 and work function</td> <td>1/2</td> </tr> </table> <p>$h\nu = \phi_0 + k_{max}$ or $h\nu = h\nu_0 + \frac{1}{2}mv_{max}^2$</p> <p>Important features (i) k_{max} depends linearly on frequency ν. (ii) Existence of threshold frequency for the metal surface. (Any other two correct features.)</p> <p>$h\nu = \phi_0 + k_{max}$</p> <p>$\frac{hc}{\lambda_1} = \frac{hc}{\lambda_0} + k_{max}$ -----(i)</p> <p>$\frac{hc}{\lambda_2} = \frac{hc}{\lambda_0} + 2k_{max}$ -----(ii)</p> <p>From (i) and (ii)</p> <p>$\frac{2hc}{\lambda_1} - \frac{hc}{\lambda_2} = \frac{hc}{\lambda_0}$</p>	(i)	Einstein's Photoelectric equation	1/2	(ii)	Important features	1/2 + 1/2	(iii)	Derivation of expressions for λ_0 and work function	1/2	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	
(i)	Einstein's Photoelectric equation	1/2										
(ii)	Important features	1/2 + 1/2										
(iii)	Derivation of expressions for λ_0 and work function	1/2										

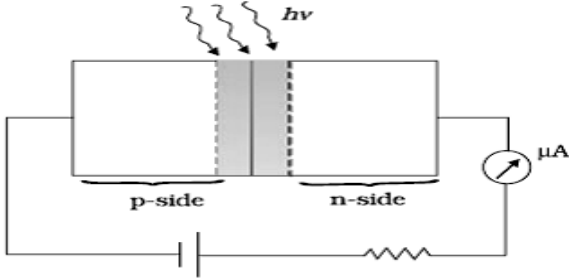
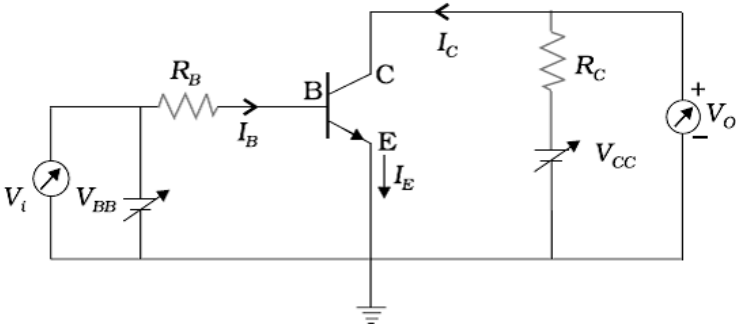
	$\frac{1}{\lambda_0} = \left(\frac{2}{\lambda_1} - \frac{1}{\lambda_2} \right)$ $\lambda_0 = \frac{\lambda_1 \lambda_2}{2\lambda_2 - \lambda_1}$ <p>Work function $\phi_0 = \frac{hc}{\lambda_0} = \frac{hc(2\lambda_2 - \lambda_1)}{\lambda_1 \lambda_2}$</p>	<p>1/2</p> <p>1/2</p>	<p>3</p>									
<p>Set1 Q14 Set2 Q22 Set3 Q19</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%;">(i)</td> <td style="width: 70%;">Drawing of trajectory</td> <td style="width: 25%; text-align: right;">1</td> </tr> <tr> <td>(ii)</td> <td>Explanation of information on the size of nucleus</td> <td style="text-align: right;">1/2</td> </tr> <tr> <td>(iii)</td> <td>Proving that nuclear density is independent of A</td> <td style="text-align: right;">1 1/2</td> </tr> </table> </div> <div style="text-align: center; margin-bottom: 10px;">  </div> <p>Only a small fraction of the incident α – particles rebound. This shows that the mass of the atom is concentrated in a small volume in the form of nucleus and gives an idea of the size of nucleus.</p> <p>Radius of nucleus $R = R_0 A^{\frac{1}{3}}$</p> <p>Density = $\frac{\text{mass}}{\text{volume}}$</p> $= \frac{mA}{\frac{4}{3}\pi R^3}$ <p style="text-align: center;">where, m: mass of one nucleon A: Mass number</p> $= \frac{mA}{\frac{4}{3}\pi (R_0 A^{\frac{1}{3}})^3}$ $= \frac{3m}{4\pi R_0^3}$ <p>=> Nuclear matter density is independent of A</p>	(i)	Drawing of trajectory	1	(ii)	Explanation of information on the size of nucleus	1/2	(iii)	Proving that nuclear density is independent of A	1 1/2	<p>1</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>3</p>
(i)	Drawing of trajectory	1										
(ii)	Explanation of information on the size of nucleus	1/2										
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	<p style="text-align: center;">OR</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Distinction between nuclear fission and nuclear fusion</td> <td style="text-align: right; padding: 5px;">$\frac{1}{2} + \frac{1}{2}$</td> </tr> <tr> <td style="padding: 5px;">Showing release of energy in both processes</td> <td style="text-align: right; padding: 5px;">$\frac{1}{2}$</td> </tr> <tr> <td style="padding: 5px;">Calculation of release of energy</td> <td style="text-align: right; padding: 5px;">$1 \frac{1}{2}$</td> </tr> </table> <p>The breaking of heavy nucleus into smaller fragments is called nuclear fission; the joining of lighter nuclei to form a heavy nucleus is called nuclear fusion.</p> <p>Binding energy per nucleon, of the daughter nuclei, in both processes, is more than that of the parent nuclei. The difference in binding energy is released in the form of energy. In both processes some mass gets converted into energy.</p> <p>Alternativey: In both processes, some mass gets converted into energy.</p> <p>Energy Released</p> $Q = [m({}_1^2H) + m({}_1^3H) - m({}_2^4He) - m(n)] \times 931.5 \text{ MeV}$ $= [2.014102 + 3.016049 - 4.002603 - 1.008665] \times 931.5 \text{ MeV}$ $= 0.018883 \times 931.5 \text{ MeV}$ $= 17.59 \text{ MeV}$	Distinction between nuclear fission and nuclear fusion	$\frac{1}{2} + \frac{1}{2}$	Showing release of energy in both processes	$\frac{1}{2}$	Calculation of release of energy	$1 \frac{1}{2}$	<p>$\frac{1}{2} + \frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p>	<p>3</p>
Distinction between nuclear fission and nuclear fusion	$\frac{1}{2} + \frac{1}{2}$								
Showing release of energy in both processes	$\frac{1}{2}$								
Calculation of release of energy	$1 \frac{1}{2}$								
<p>Set1 Q15 Set2 Q11 Set3 Q20</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Drawing Block diagram of detector</td> <td style="text-align: right; padding: 5px;">1</td> </tr> <tr> <td style="padding: 5px;">Showing detection of Message signal from Input AM Wave</td> <td style="text-align: right; padding: 5px;">2</td> </tr> </table> <div style="text-align: center; margin-top: 10px;"> <p style="text-align: center;">AM input wave Rectified wave Output (without RF component)</p> </div> <p>[Note: Award these 3 marks irrespective of the way the student attempts the question.]</p>	Drawing Block diagram of detector	1	Showing detection of Message signal from Input AM Wave	2	<p>1</p> <p>1+1</p> <p>1</p>	<p>3</p>		
Drawing Block diagram of detector	1								
Showing detection of Message signal from Input AM Wave	2								
<p>Set1 Q16 Set2 Q12 Set3 Q21</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Drawing of Plots of Part (i) & (ii)</td> <td style="text-align: right; padding: 5px;">$\frac{1}{2} + \frac{1}{2}$</td> </tr> <tr> <td style="padding: 5px;">Finding the values of emf and internal resistance</td> <td style="text-align: right; padding: 5px;">1 + 1</td> </tr> </table>	Drawing of Plots of Part (i) & (ii)	$\frac{1}{2} + \frac{1}{2}$	Finding the values of emf and internal resistance	1 + 1				
Drawing of Plots of Part (i) & (ii)	$\frac{1}{2} + \frac{1}{2}$								
Finding the values of emf and internal resistance	1 + 1								

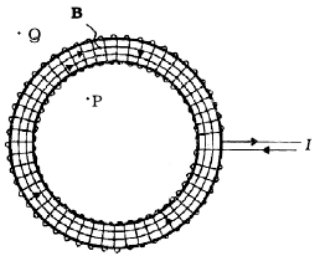
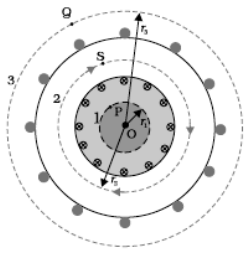
	 <p>(If the student just writes the relations $V = \varepsilon - IR$ and $V = \frac{\varepsilon R}{R+r}$ but does not draw the plots, award $\frac{1}{2}$ mark.)</p> $I = \frac{E}{R+r}$ $I = \frac{E}{4+r}$ <p>$\Rightarrow E = 4 + r \dots\dots(i)$</p> <p>Also</p> $0.5 = \frac{E}{9+r}$ $E = 4.5 + 0.5 r \dots\dots(ii)$ <p>From equation (i) & (ii)</p> $4 + r = 4.5 + 0.5 r$ $\therefore r = 1 \Omega$ <p>Using this value of r, we get</p> $E = 5V$	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>3</p>					
<p>Set1 Q17 Set2 Q13 Set3 Q22</p>	<table border="1"> <tr> <td>Determination of C_1 and C_2</td> <td>2</td> </tr> <tr> <td>Determination of Charge on each capacitor in parallel combination</td> <td>$\frac{1}{2} + \frac{1}{2}$</td> </tr> </table>	Determination of C_1 and C_2	2	Determination of Charge on each capacitor in parallel combination	$\frac{1}{2} + \frac{1}{2}$		
Determination of C_1 and C_2	2						
Determination of Charge on each capacitor in parallel combination	$\frac{1}{2} + \frac{1}{2}$						

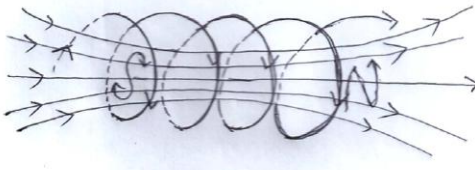
	<p>Energy stored in a capacitor</p> $E = \frac{1}{2} CV^2$ <p>In series combination</p> $0.045 = \frac{1}{2} \frac{C_1 C_2}{C_1 + C_2} (100)^2$ $\Rightarrow \frac{C_1 C_2}{C_1 + C_2} = 0.09 \times 10^{-4} \quad \dots\dots(i)$ <p>In Parallel combination</p> $0.25 = \frac{1}{2} (C_1 + C_2) (100)^2$ $\Rightarrow C_1 + C_2 = 0.5 \times 10^{-4} \quad \dots\dots(ii)$ <p>On simplifying (i) & (ii)</p> $C_1 C_2 = 0.045 \times 10^{-8}$ $(C_1 - C_2)^2 = (C_1 + C_2)^2 - 4C_1 C_2$ $= (0.5 \times 10^{-4})^2 - 4 \times 0.045 \times 10^{-8}$ $= 0.25 \times 10^{-8} - 0.180 \times 10^{-8}$ $(C_1 - C_2)^2 = 0.07 \times 10^{-8}$ $(C_1 - C_2) = 2.6 \times 10^{-5} = 0.26 \times 10^{-4} \quad \dots\dots(iii)$ <p>From (ii) and (iii) we have</p> $\Rightarrow C_1 = 0.38 \times 10^{-4} \text{ F} \ \& \ C_2 = 0.12 \times 10^{-4} \text{ F}$ <p>Charges on capacitor C_1 and C_2 in Parallel combination</p> $Q_1 = C_1 V = (0.38 \times 10^{-4} \times 100) = 0.38 \times 10^{-2} \text{ C}$ $Q_2 = C_2 V = (0.12 \times 10^{-4} \times 100) = 0.12 \times 10^{-2} \text{ C}$ <p>[Note: If the student writes the relations/ equations $E = \frac{1}{2} CV^2$</p>	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p>	
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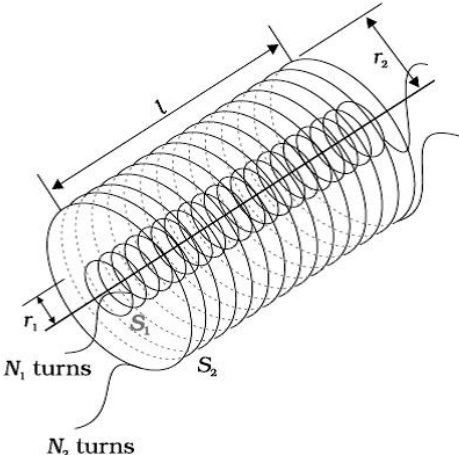
	<p>And $0.045 = \frac{1}{2} \left(\frac{C_1 C_2}{C_1 + C_2} \right) (100)^2$</p> <p>$0.25 = \frac{1}{2} (C_1 + C_2) (100)^2$</p> <p>But is unable to calculate C_1 and C_2, award him/her full 2 marks.</p> <p>Also if the student just writes $Q_1 = C_1 V = C_1 (100)$ and $Q_2 = C_2 V = C_2 (100)$ Award him/her one mark for this part of the question.]</p>		3						
<p>Set1 Q18 Set2 Q14 Set3 Q11</p>	<table border="1" data-bbox="269 495 1273 638"> <tr> <td>Working Principle</td> <td>1</td> </tr> <tr> <td>Finding the required resistance</td> <td>1</td> </tr> <tr> <td>Finding the resistance G of the Galvanometer</td> <td>1</td> </tr> </table> <p>Working Principle: A current carrying coil experiences a torque when placed in a magnetic field which tends to rotate the coil and produces an angular deflection.</p> <p>$V = I (G + R_1)$</p> <p>$\frac{V}{2} = I (G + R_2)$</p> <p>$\Rightarrow 2 = \frac{G + R_1}{G + R_2}$</p> <p>$\Rightarrow G = R_1 - 2R_2$</p> <p>Let R_3 be the resistance required for conversion into voltmeter of range 2V $\therefore 2V = I_g (G + R_3)$ Also $V = I_g (G + R_1)$ $\therefore 2 = \frac{G + R_3}{G + R_1}$</p> <p>$\therefore R_3 = G + 2R_1 = R_1 - 2R_2 + 2R_1 = 3R_1 - 2R_2$</p>	Working Principle	1	Finding the required resistance	1	Finding the resistance G of the Galvanometer	1	<p>1</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p>	3
Working Principle	1								
Finding the required resistance	1								
Finding the resistance G of the Galvanometer	1								
<p>Set1 Q19 Set2 Q15 Set3 Q12</p>	<table border="1" data-bbox="261 1451 1265 1598"> <tr> <td>Fabrication of photodiode</td> <td>$\frac{1}{2}$</td> </tr> <tr> <td>Working with suitable diagram</td> <td>1 $\frac{1}{2}$</td> </tr> <tr> <td>Reason</td> <td>1</td> </tr> </table> <p>It is fabricated with a transparent window to allow light to fall on diode.</p> <p>When the photodiode is illuminated with photons of energy ($h\nu > E_g$) greater than the energy gap of the semiconductor, electron – holes pairs are generated. These get separated due to the Junction electric field (before they recombine) which produces an emf.</p>	Fabrication of photodiode	$\frac{1}{2}$	Working with suitable diagram	1 $\frac{1}{2}$	Reason	1	<p>$\frac{1}{2}$</p> <p>1</p>	
Fabrication of photodiode	$\frac{1}{2}$								
Working with suitable diagram	1 $\frac{1}{2}$								
Reason	1								

	 <p>Reason: It is easier to observe the change in the current, with change in light intensity, if a reverse bias is applied.</p> <p>Alternatively, The fractional change in the minority carrier current, obtained under reverse bias, is much more than the corresponding fractional change in majority carrier current obtained under forward bias.</p>	<p>1/2</p> <p>1</p> <p>3</p>									
<p>Set1 Q20 Set2 Q16 Set3 Q13</p>	<table border="1" data-bbox="264 842 1265 1010"> <tr> <td>Circuit diagram of Transistor amplifier in CE-configuration</td> <td>1 1/2</td> </tr> <tr> <td>Definition and determination of</td> <td></td> </tr> <tr> <td>(i) Input resistance</td> <td>1 1/2</td> </tr> <tr> <td>(ii) Current amplification factor</td> <td></td> </tr> </table>  <p>Input resistance</p> $R_i = \left(\frac{\Delta V_{BE}}{\Delta I_B} \right)_{V_{CE}}$ <p>Current amplification factor</p> $\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B} \right)_{V_{CE}}$	Circuit diagram of Transistor amplifier in CE-configuration	1 1/2	Definition and determination of		(i) Input resistance	1 1/2	(ii) Current amplification factor		<p>1 1/2</p> <p>1/2</p> <p>1/2</p>	
Circuit diagram of Transistor amplifier in CE-configuration	1 1/2										
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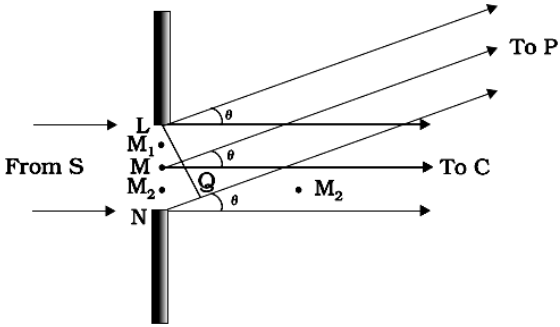
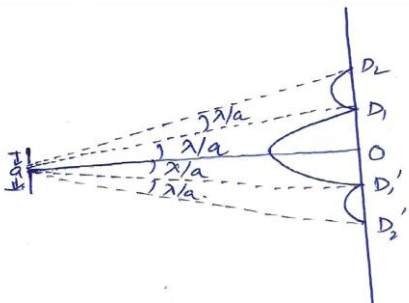
	<p>The value of input resistance is determined from the slope of I_B versus V_{BE} plot at constant V_{CE}.</p> <p>The value of current amplification factor is obtained from the slope of collector I_C versus V_{CE} plot using different values of I_B.</p> <p>(If a student uses typical characteristics to determine these values, full credit of one mark should be given)</p>	<p>1/2</p>	<p>3</p>						
<p>Set1 Q21 Set2 Q17 Set3 Q14</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Finding the spacing between two slits</td> <td style="text-align: right; padding: 5px;">1</td> </tr> <tr> <td style="padding: 5px;">Effect on wavelength and frequency of reflected and refracted light</td> <td style="text-align: right; padding: 5px;">2</td> </tr> </table> <p>(a) Angular width of fringes $\theta = \lambda/d$, where d = separation between two slits Here $\theta = 0.1^\circ = 0.1 \times \frac{\pi}{180}$ radian $\therefore d = \frac{600 \times 10^{-9} \times 180}{0.1 \times \pi}$ $= 3.43 \times 10^{-4} m$ $= 0.34 m$</p> <p>(b) <u>For Reflected light:</u> Wavelength remains same Frequency remains same <u>For Refracted light:</u> Wavelength decreases Frequency remains same</p>	Finding the spacing between two slits	1	Effect on wavelength and frequency of reflected and refracted light	2	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>3</p>		
Finding the spacing between two slits	1								
Effect on wavelength and frequency of reflected and refracted light	2								
<p>Set1 Q22 Set2 Q18 Set3 Q15</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Change in the Brightness of the bulb in cases (i), (ii) & (iii)</td> <td style="text-align: right; padding: 5px;">1/2 + 1/2 + 1/2</td> </tr> <tr> <td style="padding: 5px;">Justification</td> <td style="text-align: right; padding: 5px;">1/2 + 1/2 + 1/2</td> </tr> </table> <p>(i) Increases $X_L = \omega L$ As number of turns decreases, L decreases, hence current through bulb increases. / Voltage across bulb increases.</p> <p>(ii) Decreases Iron rod increases the inductance which increases X_L, hence current through the bulb decreases. / Voltage across bulb decreases.</p> <p>(iii) Increases Under this condition ($X_C = X_L$) the current through the bulb will become maximum / increase.</p>	Change in the Brightness of the bulb in cases (i), (ii) & (iii)	1/2 + 1/2 + 1/2	Justification	1/2 + 1/2 + 1/2	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>3</p>		
Change in the Brightness of the bulb in cases (i), (ii) & (iii)	1/2 + 1/2 + 1/2								
Justification	1/2 + 1/2 + 1/2								
<p>Set1 Q23 Set2 Q23 Set3 Q23</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">(i) Name of device and Principle of working</td> <td style="text-align: right; padding: 5px;">1/2 + 1</td> </tr> <tr> <td style="padding: 5px;">(ii) Possibility and explanation</td> <td style="text-align: right; padding: 5px;">1/2</td> </tr> <tr> <td style="padding: 5px;">(iii) Values displayed by students and teachers</td> <td style="text-align: right; padding: 5px;">1+1</td> </tr> </table>	(i) Name of device and Principle of working	1/2 + 1	(ii) Possibility and explanation	1/2	(iii) Values displayed by students and teachers	1+1		
(i) Name of device and Principle of working	1/2 + 1								
(ii) Possibility and explanation	1/2								
(iii) Values displayed by students and teachers	1+1								

	<p>(i) Transformer Working Principle: Mutual induction Whenever an alternative voltage is applied in the primary windings, an emf is induced in the secondary windings.</p> <p>(ii) No, There is no induced emf for a dc voltage in the primary</p> <p>(iii) Inquisitive nature/ Scientific temperament (any one) Conceren for students / Helpfulness / Professional honesty(any one) (Any other relevant values)</p>	<p>1/2</p> <p>1</p> <p>1/2</p> <p>1</p> <p>1</p>	<p>4</p>
<p>Set1 Q24 Set2 Q26 Set3 Q25</p>	<p>(a) Statement of Ampere’s circuital law 1 Expression for the magnetic field 1 1/2</p> <p>(b) Depiction of magnetic field lines and specifying polarity 1/2 + 1/2 Showing the solenoid as bar magnet 1 1/2</p> <p>(a) Line integral of magnetic field over a closed loop is equal to the μ_0 times the total current passing through the surface enclosed by the loop . Alternatively</p> $\oint \vec{B} \cdot d\vec{l} = \mu_0 I$  <p>(a)</p>  <p>(b)</p> <p>Let the current flowing through each turn of the toroid be I. The total number of turns equals $n \cdot (2\pi r)$ where n is the number of turns per unit length. Applying Ampere’s circuital law, for the Amperian loop, for interior points.</p>	<p>1</p> <p>1/2</p>	

	<p> $\oint \vec{B} \cdot d\vec{l} = \mu_0(n2\pi rI)$ $\oint Bdl\cos 0 = \mu_0 n 2\pi rI$ $\Rightarrow B \times 2\pi r = \mu_0 n 2\pi rI$ $B = \mu_0 nI$ </p> <p>(b)</p>  <p>The solenoid contains N loops, each carrying a current I. Therefore, each loop acts as a magnetic dipole. The magnetic moment for a current I, flowing in loop of area (vector) A is given by m = IA</p> <p>The magnetic moments of all loops are aligned along the same direction. Hence, net magnetic moment equals NIA.</p> <p style="text-align: center;">OR</p> <table border="1" data-bbox="266 1192 1268 1371"> <tr> <td>(a) Definition of mutual inductance and S.I. unit</td> <td>1 ½</td> </tr> <tr> <td>(b) Derivation of expression for the mutual inductance of two long coaxial solenoids</td> <td>2 ½</td> </tr> <tr> <td>(c) Finding out the expression for the induced emf</td> <td>1</td> </tr> </table> <p>(a) $\phi = MI$ Mutual inductance of two coils is equal to the magnetic flux linked with one coil when a unit current is passed in the other coil.</p> <p>Alternatively,</p> $e = -M \frac{dI}{dt}$ <p>Mutual inductance is equal to the induced emf set up in one coil when the rate of change of current flowing through the other coil is unity.</p> <p>SI unit : henry / (Weber ampere⁻¹) / (volt second ampere⁻¹)</p>	(a) Definition of mutual inductance and S.I. unit	1 ½	(b) Derivation of expression for the mutual inductance of two long coaxial solenoids	2 ½	(c) Finding out the expression for the induced emf	1	<p>½</p> <p>½</p> <p>½ + ½</p> <p>½</p> <p>½</p> <p>½</p> <p>5</p> <p>1</p>	
(a) Definition of mutual inductance and S.I. unit	1 ½								
(b) Derivation of expression for the mutual inductance of two long coaxial solenoids	2 ½								
(c) Finding out the expression for the induced emf	1								

	<p>(Any one)</p> <p>(b) .</p>  <p>Let a current I_2 flow through S_2. This sets up a magnetic flux ϕ_1 through each turn of the coil S_1.</p> <p>Total flux linked with S_1</p> $N_1 \phi_1 = M_{12} I_2 \quad \dots (i)$ <p>where M_{12} is the mutual inductance between the two solenoids</p> <p>Magnetic field due to the current I_2 in S_2 is $\mu_0 n_2 I_2$.</p> <p>Therefore, resulting flux linked with S_1.</p> $N_1 \phi_1 = [(n_1 \ell) \pi r_1^2] (\mu_0 n_2 I_2) \quad \dots (ii)$ <p>Comparing (i) & (ii), we get</p> $M_{12} I_2 = (n_1 \ell) \pi r_1^2 (\mu_0 n_2 I_2)$ $\therefore M_{12} = \mu_0 n_1 n_2 \pi r_1^2 \ell$ <p>(c) Let a magnetic flux be (ϕ_1) linked with coil C_1 due to current (I_2) in coil C_2;</p> <p>We have :</p> $\phi_1 \propto I_2$ $\Rightarrow \phi_1 = M I_2$	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p>	
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	$\therefore \frac{d\phi_1}{dt} = M \frac{dl_2}{dt}$ $\Rightarrow e = -M \frac{dl_2}{dt}$	<p>1/2</p> <p>1/2</p>	<p>5</p>
<p>Set1 Q25 Set2 Q24 Set3 Q26</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>(a) Explanation of diffraction pattern using Huygen's construction 2</p> <p>(b) Showing the angular width of first diffraction fringe as half of the central fringe 2</p> <p>(c) Explanation of decrease in intensity with increasing n 1</p> </div> <p>(a).</p>  <p>We can regard the total contribution of the wavefront LN at some point P on the screen, as the resultant effect of the superposition of its wavelets like LM, MM₂, M₂N. These have to be superposed taking into account their proper phase differences. We, therefore, get maxima and minima, i.e a diffraction pattern, on the screen.</p> <p>(b)</p>  <p>Condition for first minimum on the screen</p> $a \sin \theta = \lambda$ $\Rightarrow \theta = \lambda/a$ <p>\therefore angular width of the central fringe on the screen (from figure)</p>	<p>1</p> <p>1</p> <p>1/2</p> <p>1/2</p>	

$$= 2\theta = 2\lambda/a$$

Angular width of first diffraction fringe (From fig) = λ/a

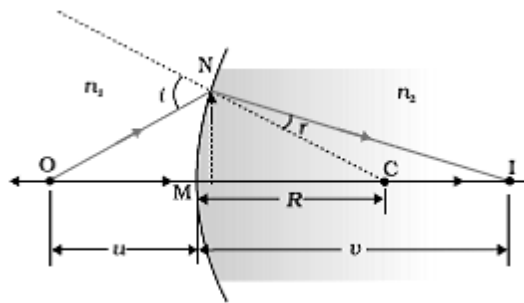
Hence angular width of central fringe is twice the angular width of first fringe.

Maxima become weaker and weaker with increasing n . This is because the effective part of the wavefront, contributing to the maxima, becomes smaller and smaller, with increasing n .

OR

a) Drawing the ray diagram showing the image formation	1
Derivation of relationship	2
b) Ray diagram	1/2
Similar relation	1/2
Derivation of lens maker's formula	1

(a)



(Deduct 1/2 mark for not showing direction of propagation of ray)

For small angles

$$\angle NOM \approx \tan \angle NOM = \frac{MN}{OM}$$

$$\angle NCM \approx \tan \angle NCM = \frac{MN}{MC}$$

$$\angle NIM \approx \tan \angle NIM = \frac{MN}{MI}$$

In $\triangle NOC$, $\angle i = \angle NOM + \angle NCM$

$$\therefore \angle i = \frac{MN}{OM} + \frac{MN}{MC} \quad \dots (i)$$

Similarly

$$\begin{aligned} \angle r &= \angle NCM - \angle NIM \\ &= \frac{MN}{MC} - \frac{MN}{MI} \quad \dots(ii) \end{aligned}$$

Using Snell's Law

$$n_1 \sin i = n_2 \sin r$$

For small angles

$$n_1 i^\theta = n_2 r$$

Substituting for i and r, we get

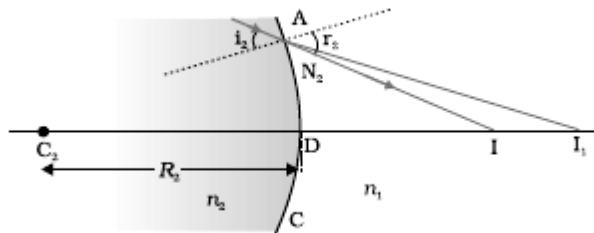
$$\frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$$

Here, $OM = -u$, $MI = +v$, $MC = +R$

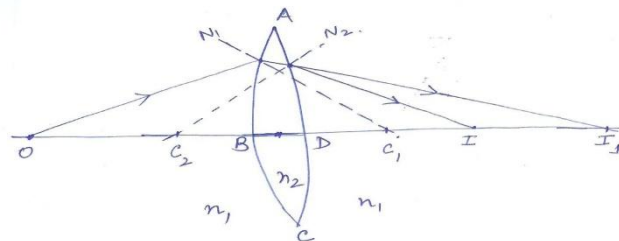
Substituting these, we get

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

b)



(Alternatively accept this Ray diagram)

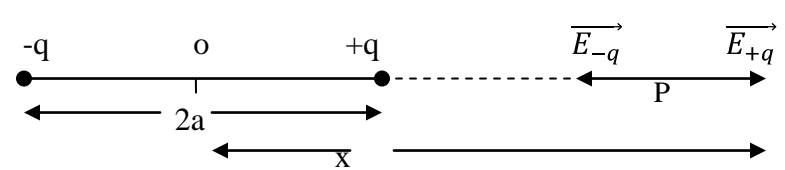


Similarly relation for the surface ADC.

1/2

1/2

1/2

	$\frac{-n_2}{DI_1} + \frac{n_1}{DI} = \frac{n_2 - n_1}{DC_2} \quad \dots(i)$ <p>Refraction at the first surface ABC of the lens.</p> $\frac{n_1}{OB} + \frac{n_2}{BI_1} = \frac{n_2 - n_1}{BC_1} \quad \dots(ii)$ <p>Adding (i) and (ii), and taking $BI_1 \approx DI_1$, we get</p> $\frac{n_1}{OB} + \frac{n_1}{DI} = (n_2 - n_1) \left(\frac{1}{BC_1} + \frac{1}{DC_2} \right)$ <p>Here, $OB = -u$</p> $DI = +v$ $BC_1 = +R_1$ $DC_2 = -R_2$ $\Rightarrow \frac{n_1}{-u} + \frac{n_1}{v} = (n_2 - n_1) \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$ $\Rightarrow n_1 \left(\frac{1}{v} + \frac{1}{u} \right) = (n_2 - n_1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$ $\Rightarrow \frac{1}{f} = \left(\frac{n_2}{n_1} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$	<p>1/2</p> <p>1/2</p> <p>1/2</p>	<p>5</p>
<p>Set1 Q26 Set2 Q25 Set3 Q24</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>a) Derivation of the expression for the Electric field E and its limiting value 3</p> <p>b) Finding the net electric flux 2</p> </div> <p>a)</p>  <p>Electric field intensity at point p due to charge -q</p>	<p>1/2</p>	

$$\vec{E}_{-q} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{(x+a)^2} (\hat{x})$$

Due to charge +q

$$\vec{E}_{+q} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{(x-a)^2} (\hat{x})$$

Net Electric field at point p

$$\vec{E} = \vec{E}_{-q} + \vec{E}_{+q}$$

$$= \frac{q}{4\pi\epsilon_0} \times \left[\frac{1}{(x-a)^2} - \frac{1}{(x+a)^2} \right] (\hat{x})$$

$$= \frac{q}{4\pi\epsilon_0} \left[\frac{4ax}{(x^2-a^2)^2} \right] (\hat{x})$$

$$= \frac{1}{4\pi\epsilon_0} \frac{(q \times 2a) 2x}{(x^2-a^2)^2} (\hat{x})$$

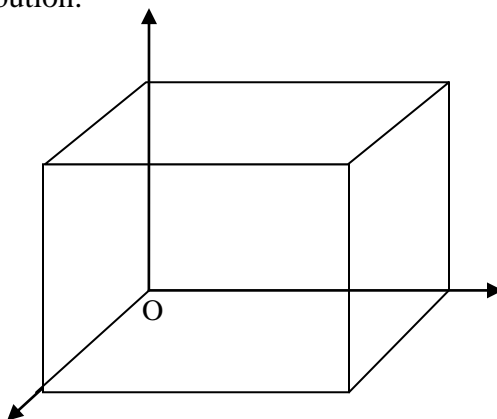
$$\vec{E} = \frac{1}{4\pi\epsilon_0} \cdot \frac{2px}{(x^2-a^2)^2} \hat{x}$$

For $x \gg a$

$$(x^2 - a^2)^2 \simeq x^4$$

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \cdot \frac{2p}{x^3} \hat{x}$$

- b) Only the faces perpendicular to the direction of x-axis, contribute to the Electric flux. The remaining faces of the cube give zero contribution.



$$\text{Total flux } \phi = \phi_I + \phi_{II}$$

$$= \oint_I \vec{E} \cdot d\vec{s} + \oint_{II} \vec{E} \cdot d\vec{s}$$

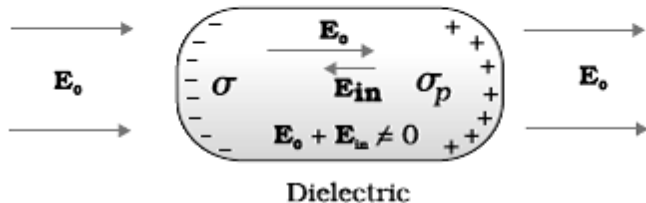
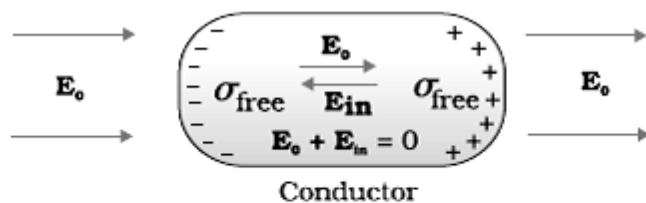


$$= 0 + 2(a) \cdot a^2$$

$$\therefore \phi = 2a^3$$

OR

a) Explanation of difference in behavior of (i) conductor (ii) dielectric	1+1
Definition of polarization and its relation with susceptibility	1/2 + 1/2
b) (i) Finding the force on the charge at centre and the charge at point A	1/2 + 1/2
(ii) Finding Electric flux through the shell	1



In the presence of Electric field, the free charge carriers, in a conductor, move the charge distribution in the conductor readjusts itself so that the net Electric field within the conductor becomes zero.

In a dielectric, the external Electric field induces a net dipole moment, by stretching /reorienting the molecules. The Electric field, due to this induced dipole moment, opposes ,but does not exactly cancel, the external Electric field.

Polarisation: Induced Dipole moment, per unit volume, is called the polarization. For Linear isotropic dielectrics having a susceptibility χ_c , we have

	<p>$P = X_e E$</p> <p>B (i) Net Force on the charge $\frac{Q}{2}$, placed at the centre of the shell, Is zero.</p> <p>Force on charge '2Q' kept at point A</p> <p>$F = E \times 2Q = \frac{1\left(\frac{3Q}{2}\right)2Q}{4\pi\epsilon_0 r^2} = \frac{(K)3Q^2}{r^2}$</p> <p>Electric flux through the shell</p> <p>$\phi = \frac{Q}{2\epsilon_0}$</p>	<p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>$\frac{1}{2}$</p> <p>1</p>	<p>5</p>
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