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SET – 1

Series : BVM/1

कोड नं.
Code No. **55/1/1**

रोल नं.
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 **15** 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 **27** 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 जाएगा । 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 **15** 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 **27** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minute 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) ***सभी*** *प्रश्न अनिवार्य हैं । इस प्रश्न-पत्र में कुल 27 प्रश्न हैं ।*

(ii) *इस प्रश्न-पत्र के* ***चार*** *भाग हैं : खण्ड-**अ**, खण्ड-**ब**, खण्ड-**स** और खण्ड-**द** ।*

(iii) *खण्ड-**अ** में 5 प्रश्न हैं, प्रत्येक का 1 अंक है । खण्ड-**ब** में 7 प्रश्न हैं, प्रत्येक के 2 अंक हैं । खण्ड-**स** में 12 प्रश्न हैं, प्रत्येक के 3 अंक हैं । खण्ड-**द** में 3 प्रश्न हैं, प्रत्येक के 5 अंक हैं ।*

(iv) प्रश्न–पत्र में समग्र पर कोई विकल्प नहीं है । तथापि **एक** अंक वाले **दो** प्रश्नों में, **दो** अंकों वाले **दो** प्रश्नों में, **तीन** अंकों वाले **चार** प्रश्नों में और **पाँच** अंकों वाले **तीनों** प्रश्नों में आन्तरिक चयन प्रदान किया गया है । ऐसे प्रश्नों में आपको दिए गए चयन में से केवल **एक** प्रश्न ही करना है ।

(v) जहाँ आवश्यक हो, आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :

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

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

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

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

$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

इलेक्ट्रॉन का द्रव्यमान $(m_e) = 9.1 \times 10^{-31}$ kg

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

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

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

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

General Instructions :

(i) ***All*** *questions are compulsory. There are* ***27*** *questions in all.*

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

(iii) *Section* ***A*** *contains* ***five*** *questions of* ***one*** *mark each, Section* ***B*** *contains* ***seven*** *questions of* ***two*** *marks each, Section* ***C*** *contains* ***twelve*** *questions of* ***three*** *marks each, and Section* ***D*** *contains* ***three*** *questions of* ***five*** *marks each.*

(iv) *There is no overall choice. However, an internal choice(s) has been provided in* ***two*** *questions of* ***one*** *mark,* ***two*** *questions of* ***two*** *marks,* ***four*** *questions of* ***three*** *marks and* ***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 :*

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

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

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

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

$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron $(m_e) = 9.1 \times 10^{-31}$ kg

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

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

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

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

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खण्ड – अ
SECTION – A

1. किसी अनावेशित चालक प्लेट के निकट स्थित किसी बिन्दु आवेश – Q के विद्युत क्षेत्र के पैटर्न को दर्शाइए। 1

Draw the pattern of electric field lines, when a point charge – Q is kept near an uncharged conducting plate.

2. यदि किसी चालक की लम्बाई और उसके ताप को नियत रखते हुए उसके सिरों पर अनुप्रयुक्त विभवान्तर को दो गुना कर दिया जाए, तो इलेक्ट्रॉनों की गतिशीलता किस प्रकार परिवर्तित होगी ? 1

How does the mobility of electrons in a conductor change, if the potential difference applied across the conductor is doubled, keeping the length and temperature of the conductor constant ?

3. प्रकाश विद्युत उत्सर्जन के संदर्भ में "देहली आवृत्ति" की परिभाषा लिखिए। 1

अथवा

विद्युतचुम्बकीय विकिरण के फोटॉन चित्रण में पद "तीव्रता" की परिभाषा लिखिए।

Define the term "threshold frequency", in the context of photoelectric emission.

OR

Define the term "Intensity" in photon picture of electromagnetic radiation.

4. ध्रुवण कोण 30° के किसी सघन माध्यम में प्रकाश की चाल क्या है ? 1

What is the speed of light in a denser medium of polarising angle 30° ?

5. संचरण की व्योम तरंग विधा में, प्रेषक सिग्नल के आवृत्ति परिसर को 30 MHz से कम पर प्रतिबंधित क्यों किया जाता है ? 1

अथवा

भू-तरंग संचरण में प्रसारण क्षेत्र परिसर किन कारकों पर निर्भर करता है ?

In sky wave mode of propagation, why is the frequency range of transmitting signals restricted to less than 30 MHz ?

OR

On what factors does the range of coverage in ground wave propagation depend ?

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खण्ड – ब

SECTION – B

6. दो बल्बों के अनुमतांक (P_1, V) और (P_2, V) हैं । यदि इन बल्बों के (i) श्रेणी संयोजन, (ii) पार्श्व संयोजन को किसी आपूर्ति V के सिरों से संयोजित किया गया है, तो P_1 और P_2 के पदों में इन दोनों संयोजनों में होने वाले शक्ति क्षय ज्ञात कीजिए । **2**

Two bulbs are rated (P_1, V) and (P_2, V). If they are connected (i) in series and (ii) in parallel across a supply V, find the power dissipated in the two combinations in terms of P_1 and P_2.

7. 1.5 अपवर्तनांक के उस समावतल लेंस की वक्रता त्रिज्या ज्ञात कीजिए जिसकी क्षमता 1.4 अपवर्तनांक के माध्यम में रखे जाने पर –5D है । **2**

अथवा

काँच के एक समबाहु प्रिज़्म का वायु में अपवर्तनांक 1.6 है । $4\sqrt{2}/5$ अपवर्तनांक के किसी माध्यम में रखे जाने पर इस प्रिज़्म का न्यूनतम विचलन परिकलित कीजिए ।

Calculate the radius of curvature of an equi-concave lens of refractive index 1.5, when it is kept in a medium of refractive index 1.4, to have a power of –5D ?

OR

An equilateral glass prism has a refractive index 1.6 in air. Calculate the angle of minimum deviation of the prism, when kept in a medium of refractive index $4\sqrt{2}/5$.

8. समान गतिज ऊर्जा के किसी एल्फा कण और किसी प्रोटॉन को इनकी गति की दिशा के अभिलम्बवत कार्यरत किसी चुम्बकीय क्षेत्र $\vec{B}$ में बारी–बारी से गुजरने दिया जाता है । इनके द्वारा चले गए वृत्तीय पथों की त्रिज्याओं का अनुपात परिकलित कीजिए । **2**

An α-particle and a proton of the same kinetic energy are in turn allowed to pass through a magnetic field $\vec{B}$, acting normal to the direction of motion of the particles. Calculate the ratio of radii of the circular paths described by them.

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9. बोर का कोणीय संवेग का क्वांटमी प्रतिबंध लिखिए । ब्रेकेट श्रेणी की लघुतम तरंगदैर्ध्य परिकलित कीजिए और उल्लेख कीजिए कि यह विद्युत चुम्बकीय स्पेक्ट्रम के किस भाग से संबंधित है । 2

अथवा

हाइड्रोजन परमाणु की प्रथम उत्तेजित अवस्था में इलेक्ट्रॉन का कक्षीय आवर्तकाल परिकलित कीजिए ।

State Bohr's quantization condition of angular momentum. Calculate the shortest wavelength of the Bracket series and state to which part of the electromagnetic spectrum does it belong.

OR

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

10. किसी TV टॉवर से प्रेषित सिग्नल को किसी निश्चित दूरी से अधिक दूरी पर प्राप्त क्यों नहीं किया जा सकता है ? प्रेषक ऐंटीना और अभिग्राही एन्टेना के बीच के इष्टतम पृथकन के लिए व्यंजक लिखिए । 2

Why a signal transmitted from a TV tower cannot be received beyond a certain distance ? Write the expression for the optimum separation between the receiving and the transmitting antenna.

11. विद्युतचुम्बकीय विकिरण का तरंग सिद्धान्त प्रकाश विद्युत प्रभाव की व्याख्या क्यों नहीं कर सका ? इस समस्या का समाधान फोटॉन चित्रण द्वारा किस प्रकार हुआ ? 2

Why is wave theory of electromagnetic radiation not able to explain photo electric effect ? How does photon picture resolve this problem ?

12. द्रव्यमान m के किसी आवेशित कण से संबद्ध दे ब्राग्ली तरंगदैर्ध्य (λ) और $1/\sqrt{V}$ के बीच विचरण को दर्शाने के लिए ग्राफ खींचिए, यहाँ V वह विभवान्तर है जिससे कण को त्वरित किया गया है । यह ग्राफ हमें कण के आवेश के परिमाण के विषय में किस प्रकार सूचित करता है ? 2

Plot a graph showing variation of de Broglie wavelength (λ) associated with a charged particle of mass m, versus $1/\sqrt{V}$, where V is the potential difference through which the particle is accelerated. How does this graph give us the information regarding the magnitude of the charge of the particle ?

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खण्ड – स

SECTION – C

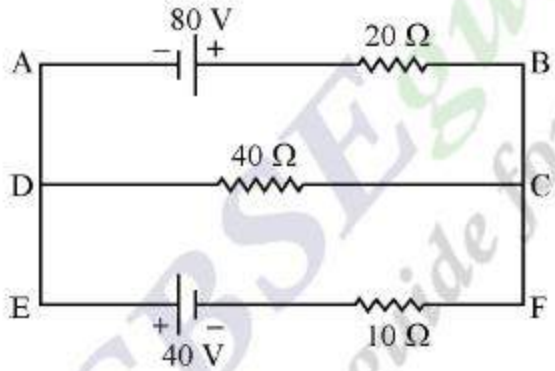
13. (a) किसी एकसमान चुम्बकीय क्षेत्र के तदनुरूपी z-अक्ष में समविभव पृष्ठ खींचिए ।

(b) किसी वैद्युत–द्विध्रुव की अक्षीय रेखा के अनुदिश किसी बिन्दु पर विद्युत विभव के लिए व्यंजक व्युत्पन्न कीजिए । **3**

(a) Draw the equipotential surfaces corresponding to a uniform electric field in the z-direction.

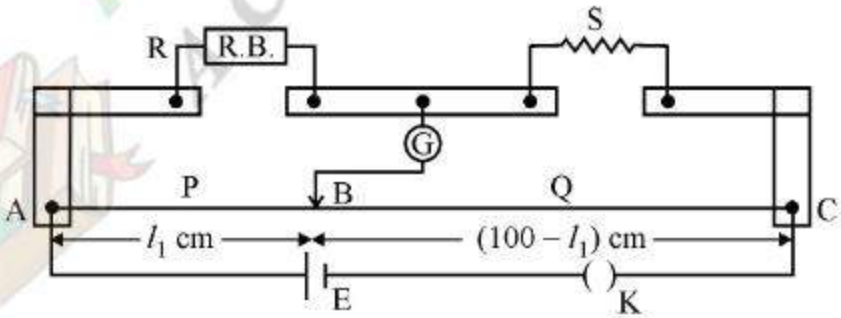
(b) Derive an expression for the electric potential at any point along the axial line of an electric dipole.

14. किरचौफ के नियमों का उपयोग करके नीचे दिए गए परिपथ में 40 Ω और 20 Ω के प्रतिरोधकों से प्रवाहित धारा परिकलित कीजिए : **3**



अथवा

किसी मीटर सेतु में अन्त्य त्रुटि क्या होती है ? इसे किस प्रकार पराभूत किया जाता है ? किसी मीटर सेतु की दो भुजाओं में क्रमशः R = 5 Ω और S प्रतिरोध हैं । जब प्रतिरोध S को समान प्रतिरोध द्वारा शंट (पार्श्व पथ) कर दिया जाता है, तो नया संतुलन बिन्दु 1.5 l_1, पर पाया जाता है, यहाँ l_1 आरम्भिक संतुलन लम्बाई है । S का मान परिकलित कीजिए ।



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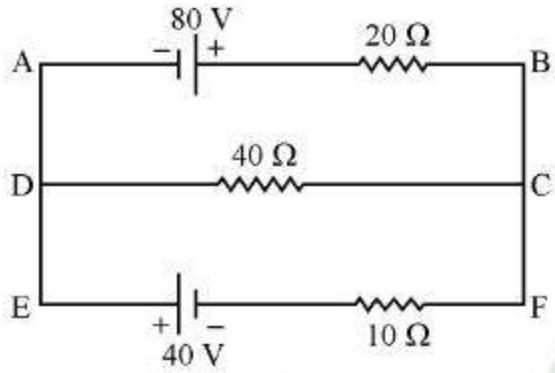
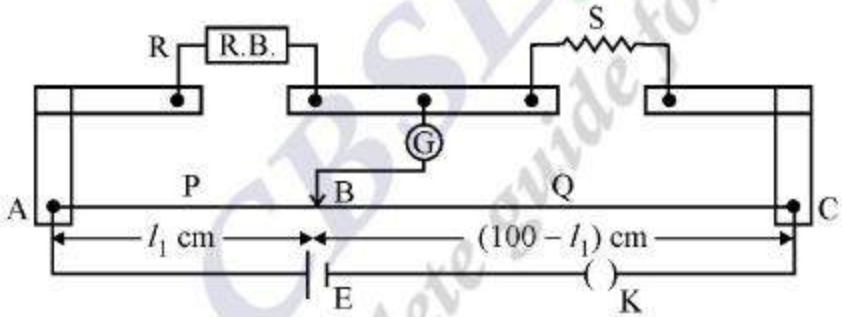
Using Kirchhoff's rules, calculate the current through the 40 Ω and 20 Ω resistors in the following circuit :



OR

What is end error in a metre bridge ? How is it overcome ? The resistances in the two arms of the metre bridge are R = 5 Ω and S respectively.

When the resistance S is shunted with an equal resistance, the new balance length found to be 1.5 l_1, where l_1 is the initial balancing length. Calculate the value of S.



15. (a) रेडार और नेत्र शल्यता में उपयोग होने वाली विद्युतचुम्बकीय तरंगों के उत्पन्न करने और संसूचन के एक स्रोत का उल्लेख कीजिए । उनकी आवृति परास लिखिए ।

(b) सिद्ध कीजिए की दोलायमान विद्युत क्षेत्र का औसत ऊर्जा घनत्व और दोलायमान चुम्बकीय क्षेत्र के औसत ऊर्जा घनत्व के समान है । **3**

(a) Identify the part of the electromagnetic spectrum used in (i) radar and (ii) eye surgery. Write their frequency range.

(b) Prove that the average energy density of the oscillating electric field is equal to that of the oscillating magnetic field.

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16. पद 'तरंगाग्र' की परिभाषा लिखिए । हाइगेन्स तरंग सिद्धान्त के नियम का उपयोग करके परावर्तन के नियम का सत्यापन कीजिए । 3

अथवा

किसी माध्यम के 'अपवर्तनांक' की परिभाषा लिखिए । उस स्थिति में अपवर्तनांक के स्नेल के नियम को सत्यापित कीजिए जब कोई समतल तरंगाग्र सघन माध्यम से विरल माध्यम में संचरण कर रहा है ।

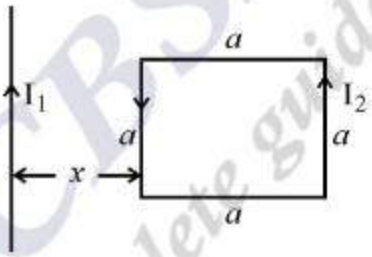
Define the term wavefront. Using Huygen's wave theory, verify the law of reflection.

OR

Define the term, "refractive index" of a medium. Verify Snell's law of refraction when a plane wavefront is propagating from a denser to a rarer medium.

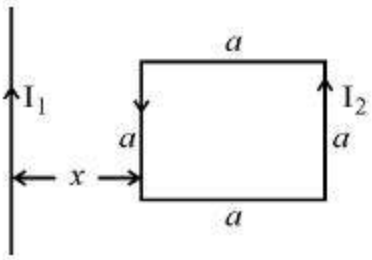
17. (a) अन्योन्य प्रेरकत्व की परिभाषा और इसका SI मात्रक लिखिए ।

(b) आरेख में दर्शाए अनुसार किसी अनन्त लम्बाई के सीधे चालक, जिससे स्थायी धारा I_1 प्रवाहित हो रही है, से दूरी x पर भुजा a का कोई वर्ग-पाश (लूप) रखा है, जिसमें धारा I_2 प्रवाहित हो रही है । इस वर्ग पाश पर लगने वाले परिणामी बल के लिए व्यंजक व्युत्पन्न कीजिए । 3



(a) Define mutual inductance and write its S.I. unit.

(b) A square loop of side 'a' carrying a current I_2 is kept at distance x from an infinitely long straight wire carrying a current I_1 as shown in the figure. Obtain the expression for the resultant force acting on the loop.



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18. (a) किसी चुम्बकीय क्षेत्र में स्थित किसी धारावाही पाश पर कार्य करने वाले बल आघूर्ण के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) किसी धारावाही कुण्डली को किसी अरीय चुम्बकीय क्षेत्र में रखने पर अरीय चुम्बकीय क्षेत्र के महत्त्व की व्याख्या कीजिए । 3

(a) Derive the expression for the torque acting on a current carrying loop placed in a magnetic field.

(b) Explain the significance of a radial magnetic field when a current carrying coil is kept in it.

19. निकट बिन्दु समायोजन स्थिति में किसी खगोलीय दूरबीन (दूरदर्शक) का नामांकित आरेख खींचिए ।

किसी वेधशाला में रखे बृहत अपवर्ती दूरदर्शक के अभिदृश्यक की फोकस दूरी 15 m और नेत्रिका की फोकस दूरी 1.0 cm है । यदि इस दूरदर्शक का उपयोग चन्द्रमा को देखने के लिए किया जाता है, तो अभिदृश्यक द्वारा बने चन्द्रमा के प्रतिबिम्ब का व्यास ज्ञात कीजिए । चन्द्रमा का व्यास 3.48×10^6 m और चन्द्रमा की कक्षा की त्रिज्या 3.8×10^8 m है । 3

Draw a labelled ray diagram of an astronomical telescope in the near point adjustment position.

A giant refracting telescope at an observatory has an objective lens of focal length 15 m and an eyepiece of focal length 1.0 cm. If this telescope is used to view the Moon, find 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.

20. (a) चुम्बकत्व के लिए गाउस का नियम लिखिए । इसके महत्त्व की व्याख्या कीजिए ।

(b) किसी छड़ चुम्बक की चुम्बकीय क्षेत्र रेखाओं के चार महत्त्वपूर्ण गुण लिखिए । 3

अथवा

प्रत्येक का एक-एक उदाहरण देते हुए अनुचुम्बकीय, प्रतिचुम्बकीय और लोह चुम्बकीय पदार्थों के बीच तीन विभेदनकारी बिन्दु लिखिए ।

(a) State Gauss's law for magnetism. Explain its significance.

(b) Write the four important properties of the magnetic field lines due to a bar magnet.

OR

Write three points of differences between para-, dia- and ferro- magnetic materials, giving one example for each.

21. किसी रेडियोएक्टिव नमूने के 'क्षयांक' की परिभाषा लिखिए । किसी दिए गए रेडियोएक्टिव नाभिक के विघटन की दर आरम्भ होने के 20 घण्टे और 30 घण्टे के पश्चात क्रमशः 10000 विघटन प्रति सेकण्ड और 5,000 विघटन प्रति सेकण्ड है । t = 0 पर नाभिकों की आरम्भिक संख्या तथा अर्धायु परिकलित कीजिए । 3

Define the term 'decay constant' of a radioactive sample. The rate of disintegration of a given radioactive nucleus is 10000 disintegrations/s and 5,000 disintegrations/s after 20 hr. and 30 hr. respectively from start. Calculate the half life and initial number of nuclei at t = 0.

22. (a) तीन फोटोडायोड D_1, D_2 और D_3 ऐसे अर्धचालकों के बने हैं जिनके बैण्ड-अन्तराल क्रमशः 2.5 eV, 2 eV और 3 eV हैं । इनमें से कौन सा फोटोडायोड 600 nm तरंगदैर्ध्य के प्रकाश का संसूचन नहीं कर सकेगा ?

(b) व्याख्या कीजिए कि फोटोडायोडों का प्रचालन पश्चदिशिक बायस में करना क्यों आवश्यक है । 3

(a) Three photo diodes D_1, D_2 and D_3 are made of semiconductors having band gaps of 2.5 eV, 2 eV and 3 eV respectively. Which of them will not be able to detect light of wavelength 600 nm ?

(b) Why photodiodes are required to operate in reverse bias ? Explain.

23. (a) n-p-n ट्रांजिस्टर के तीन खण्डों के कार्यों का संक्षेप में वर्णन कीजिए ।

(b) C-E विन्यास में n-p-n ट्रांजिस्टर के निर्गत अभिलाक्षणिक का अध्ययन करने के लिए परिपथ व्यवस्था खींचिए । व्याख्या कीजिए कि निर्गत अभिलाक्षणिक किस प्रकार प्राप्त किया जाता है । 3

अथवा

पूर्ण तरंग दिष्टकारी का परिपथ आरेख खींचकर इसकी कार्यविधि की व्याख्या कीजिए । इसके निवेशी और निर्गत तरंगरूपों को भी आलेखित कीजिए ।

(a) Describe briefly the functions of the three segments of n-p-n transistor.

(b) Draw the circuit arrangement for studying the output characteristics of n-p-n transistor in CE configuration. Explain how the output characteristics is obtained.

OR

Draw the circuit diagram of a full wave rectifier and explain its working. Also, give the input and output waveforms.

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24. (a) यदि किसी आयाम माडुलित तरंग के अधिकतम और निम्नतम आयामों को A और B द्वारा निरूपित किया गया है, तो A, B के पदों में माडुलन सूचकांक के लिए व्यंजक लिखिए ।

(b) 2 MHz आवृत्ति और 15 V शिखर वोल्टता की किसी वाहक तरंग का माडुलन करने के लिए 20 kHz आवृत्ति और 10 V शिखर वोल्टता के किसी संदेश सिग्नल का उपयोग किया गया है । माडुलन सूचकांक परिकलित कीजिए । सामान्यतः माडुलन – सूचकांक एक से कम क्यों रखा जाता है ? **3**

(a) If A and B represent the maximum and minimum amplitudes of an amplitude modulated wave, write the expression for the modulation index in terms of A & B.

(b) A message signal of frequency 20 kHz and peak voltage 10 V is used to modulate a carrier of frequency 2 MHz and peak voltage of 15 V. Calculate the modulation index. Why the modulation index is generally kept less than one ?

खण्ड – द

SECTION – D

25. (a) परिवर्ती आवृत्ति के किसी ac स्रोत के सिरों से संयोजित किसी श्रेणी LCR परिपथ की प्रतिबाधा के लिए व्यंजक लिखिए तथा ac स्रोत की आवृत्ति के साथ प्रतिबाधा के विचरण को दर्शाने के लिए ग्राफ खींचिए ।

(b) LCR परिपथ में अनुनाद की स्थिति में प्रेरक और संधारित्र के सिरों पर वोल्टताओं के बीच कितना कलान्तर होता है ?

(c) किसी प्रेरक को 200 V dc वोल्टता से संयोजित करने पर 1A धारा प्रवाहित होती है । जब इसी प्रेरक को 50 Hz आवृत्ति के 200 V के ac स्रोत से संयोजित किया जाता है, तो केवल 0.5A धारा ही प्रवाहित होती है । व्याख्या कीजिए कि दूसरे प्रकरण में धारा कम क्यों है । प्रेरक का स्वप्रेरकत्व भी परिकलित कीजिए । **5**

अथवा

(a) किसी ऐसी युक्ति का आरेख खींचिए जिसका उपयोग उच्च ac वोल्टता को निम्न ac वोल्टता में परिवर्तित करने के लिए किया जाता है और उसका कार्यकारी सिद्धांत लिखिए । इस युक्ति में होने वाले ऊर्जा–क्षय के चार स्रोत लिखिए ।

(b) कोई छोटा शहर जिसकी विद्युत शक्ति की माँग 220 V पर 1200 kW है, 440 V पर शक्ति उत्पन्न करने वाले विद्युत संयंत्र से 20 km दूर है । शक्ति संचरण के लिए उपयोग की जाने वाली दो तारों की लाइन का प्रतिरोध 0.5 Ω प्रति किलोमीटर है । यह शहर विद्युत लाइन से 4000-220 अपचायी ट्रांसफॉर्मर से होकर उपबिजलीघर पर विद्युत शक्ति प्राप्त करता है । ऊष्मा के रूप में लाइन शक्ति–क्षय का आकलन कीजिए ।

(a) In a series LCR circuit connected across an ac source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with frequency of the ac source.

(b) What is the phase difference between the voltages across inductor and the capacitor at resonance in the LCR circuit ?

(c) When an inductor is connected to a 200 V dc voltage, a current of 1A flows through it. When the same inductor is connected to a 200 V, 50 Hz ac source, only 0.5 A current flows. Explain, why ? Also, calculate the self inductance of the inductor.

OR

(a) Draw the diagram of a device which is used to decrease high ac voltage into a low ac voltage and state its working principle. Write four sources of energy loss in this device.

(b) A small town with a demand of 1200 kW of electric power at 220 V is situated 20 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is 0.5 Ω per km. The town gets the power from the line through a 4000-220 V step-down transformer at a sub-station in the town. Estimate the line power loss in the form of heat.

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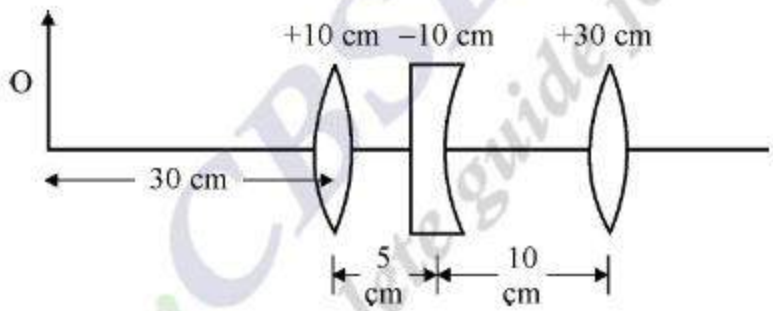
26. (a) व्यतिकरण और विवर्तन परिघटनाओं के बीच विभेदन करने वाले किन्हीं दो विशिष्ट लक्षणों का वर्णन कीजिए । यंग के द्विझिरी प्रयोग में व्यतिकरण पैटर्न की तीव्रता के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) एकल झिरी प्रयोग के कारण विवर्तन में झिरी का द्वारक 3 mm है । यदि इस झिरी पर 620 nm तरंगदैर्ध्य का कोई एकवर्णी प्रकाश अभिलम्बवत् आपतन करता है, तो पर्दे पर एक ओर प्रथम कोटि निम्निष्ट और तृतीय कोटि उच्चिष्ठ के बीच पृथकन परिकलित कीजिए । पर्दे और झिरी के बीच की दूरी 1.5 m है । **5**

अथवा

(a) किन परिस्थितियों में पूर्ण आन्तरिक परावर्तन की परिघटना का प्रेक्षण किया जाता है ? माध्यम के अपवर्तनांक और आपतन के क्रांतिक कोण के बीच संबंध प्राप्त कीजिए ।

(b) आरेख में दर्शाए अनुसार +10 cm; –10 cm और +30 cm फोकस दूरी के तीन लेंस समाक्ष व्यवस्थित किए गए हैं । इस संयोजन द्वारा बने अंतिम प्रतिबिम्ब की स्थिति ज्ञात कीजिए ।



(a) Describe any two characteristic features which distinguish between interference and diffraction phenomena. Derive the expression for the intensity at a point of the interference pattern in Young's double slit experiment.

(b) In the diffraction due to a single slit experiment, the aperture of the slit is 3 mm. If monochromatic light of wavelength 620 nm is incident normally on the slit, calculate the separation between the first order minima and the 3rd order maxima on one side of the screen. The distance between the slit and the screen is 1.5 m.

OR

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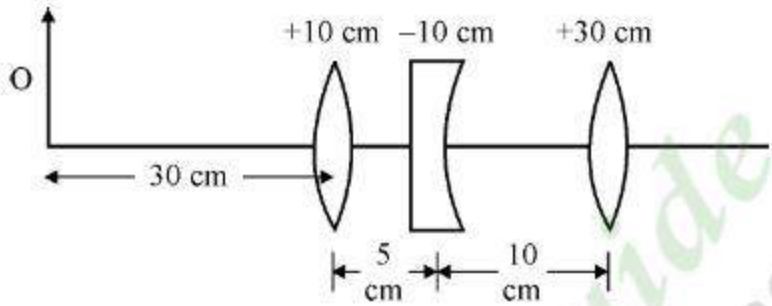
(a) Under what conditions is the phenomenon of total internal reflection of light observed ? Obtain the relation between the critical angle of incidence and the refractive index of the medium.

(b) Three lenses of focal lengths +10 cm, –10 cm and +30 cm are arranged coaxially as in the figure given below. Find the position of the final image formed by the combination.



27. (a) एक बैटरी से जुड़े किसी समान्तर पट्टिका संधारित्र की पट्टिकाओं के बीच आवेश स्थानान्तरित करने की प्रक्रिया का संक्षेप में वर्णन कीजिए । किसी संधारित्र में संचित ऊर्जा के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) किसी समान्तर पट्टिका संधारित्र को विभवान्तर V तक आवेशित किया गया है । इसे स्रोत से वियोजित करके समान धारिता के किसी अन्य अनावेशित संधारित्र के साथ संयोजित किया गया । इस संयोजन में संचित ऊर्जा और आरम्भ में एकल संधारित्र में संचित ऊर्जा का अनुपात परिकलित कीजिए । **5**

अथवा

(a) किसी वैद्युत द्विध्रुव की विषुवत रेखा के किसी बिन्दु पर विद्युत क्षेत्र के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) दो सर्वसम बिन्दु, प्रत्येक q, आवेश वायु में एक दूसरे से 2m दूरी पर रखे हैं । अज्ञात परिमाण और चिह्न का कोई तीसरा आवेश 'Q' इन आवेशों को मिलाने वाली रेखा पर इस प्रकार रखा है कि निकाय संतुलन में रहता है । आवेश Q की स्थिति और चिह्न ज्ञात कीजिए ।

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(a) Describe briefly the process of transferring the charge between the two plates of a parallel plate capacitor when connected to a battery. Derive an expression for the energy stored in a capacitor.

(b) A parallel plate capacitor is charged by a battery to a potential difference V. It is disconnected from battery and then connected to another uncharged capacitor of the same capacitance. Calculate the ratio of the energy stored in the combination to the initial energy on the single capacitor.

OR

(a) Derive an expression for the electric field at any point on the equatorial line of an electric dipole.

(b) Two identical point charges, q each, are kept 2m apart in air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q.

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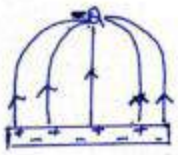
MARKING SCHEME – PHYSICS			
55/1/1			
Q. No.	**Value Points/ Expected answers**	**Marks**	**Total Marks**
1	 [Note: i) Deduct ½ mark, if arrows are not shown. ii) do not deduct any mark, if charges on the plates are not shown]	1	1
2	No Change	1	1
3	Threshold frequency equals the minimum frequency of incident radiation (light) that can cause photoemission from a given photosensitive surface. (Alternatively) The frequency below which the incident radiations cannot cause the photoemission from photosensitive surface. OR Intensity of radiation is proportional to (/ equal to) the number of energy quanta (photons) per unit area per unit time.	1	1
4	$d\mu_r = \tan 30^0 = \frac{1}{\sqrt{3}}$ (where $d\mu_r$ is the retractive index of rarer medium w.r.t denser medium) $\therefore \mu_d = \sqrt{3}$ $v = \frac{c}{\mu} = \frac{3 \times 10^8}{\sqrt{3}} = \sqrt{3} \times 10^8$ m/s [Note- Also accept if a student solves it as follows) $\mu = \tan i_p$ $\mu = \tan 30^0 = \frac{1}{\sqrt{3}}$ $\therefore v = \frac{3 \times 10^8}{\frac{1}{\sqrt{3}}} = 3\sqrt{3} \times 10^8$ m/s (Note: Award this one mark if a student just writes the formula but does not solve it.)	½ ½ ½ ½	1
5	The waves beyond 30 MHz frequency penetrate through the Ionosphere/ are not reflected back. OR Transmitted Power and Frequency	1 ½ + ½	1
	SECTION - B		
6	Calculation of Power dissipation in two combinations 1 +1 $R_1 = \frac{V^2}{P_1}$, $R_2 = \frac{V^2}{P_2}$, $P_s = \frac{V^2}{Rs} = \frac{P_1 P_2}{P_1 + P_2}$ $\frac{1}{Ps} = \frac{1}{P_1} + \frac{1}{P_2}$ $\frac{1}{Rp} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{P_1 + P_2}{V^2}$	½ ½ ½	

	$\therefore\ P_p = \frac{V^2}{R_P} = P_1 + P_2$	½	2
7	Calculation of focal length ½ Lens maker's formula ½ Calculation of radius of curvature 1		
	$f = \frac{1}{P} = \frac{1}{-5}\text{ m} = -\frac{100}{5}\text{ cm} = -20\text{ cm}$	½	
	$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R1} - \frac{1}{R2}\right)$	½	
	$\mu_2 = 1.5,\quad \mu_1 = 1.4,\quad R_1 = -R$ $R_2 = R$		
	$\frac{1}{-20} = \left(\frac{1.5}{1.4} - 1\right)\left(-\frac{1}{R} - \frac{1}{R}\right)$	½	
	$\frac{1}{-20} = \left(\frac{0.1}{1.4}\right)\left(-\frac{2}{R}\right)$		
	$R = \frac{20}{7}$ cm (= 2.86 cm)	½	2
	OR		
	Formula ½ Substitution and calculation 1½		
	$\mu = \frac{\sin\frac{(A + D_m)}{2}}{\sin A/2}$	½	
	$\mu = \frac{\mu_2}{\mu_1} = \frac{1.6}{\frac{4}{5}\sqrt{2}} = \frac{8}{4\sqrt{2}} = \sqrt{2}$	½	
	$\sqrt{2} = \frac{\sin(\frac{60+D_m}{2})}{\sin 60/2} = \frac{\sin\frac{(60+D_m)}{2}}{\sin 30}$		
	$\therefore\ \sin(\frac{60+D_m}{2}) = \sqrt{2}\,.\,\frac{1}{2} = \frac{1}{\sqrt{2}} = \sin 45^0$	½	
	$\therefore\ \frac{60+D_m}{2} = 45^o$	½	
	$\therefore\ D_m = 30^o$		2
8	Formula ½ Calculation of ratio of radii 1½		
		½	

	radius r = $\frac{mv}{q\,B}$ = $\frac{\sqrt{2mk}}{qB}$ $K_\alpha = K_{proton}$ $M_\alpha = 4\ m_p$ $q_\alpha = 2q_p$ $\frac{r_\alpha}{r_p} = \frac{\frac{\sqrt{2m_\alpha K}}{q_\alpha B}}{\frac{\sqrt{2m_p K}}{q_p B}}$ $= \sqrt{\frac{m_\alpha}{m_p}} \times \sqrt{\frac{q_p}{q_\alpha}}$ $= \sqrt{4} \times ½ = 1$	½ ½ ½	2
9	Statement of Bohr's quantization condition ½ Calculation of shortest wavelength 1 Identification of part of electromagnetic spectrum ½ Electron revolves around the nucleus only in those orbits for which the angular momentum is some integral of h/2π. (where h is planck's constant) (Also give full credit it a student write mathematically mvr = $\frac{nh}{2\pi}$) $\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ For Brackett Series, Shortest wavelength is for the transition of electrons from $n_i = \infty$ to $n_f = 4$ $\frac{1}{\lambda} = R\left(\frac{1}{4^2}\right) = \frac{R}{16}$ $\lambda = \frac{16}{R}$ m = 1458.5 nm on substitution of value of R [Note: Don't deduct any mark for this part, when a student does not substitute the value of R, to calculate the numerical value of λ] Infrared region OR Statement of the Formula for r_n ½ Statement of the formula for v_n ½ Obtaining formula for T_n ½ Getting expression for T_2 (n = 2) ½ $Radius\ r_n = \frac{h^2\epsilon_0}{\pi m e^2} n^2$	½ ½ ½ ½ ½	

	$velocity\ \ v_n = \frac{2\pi e^2}{4\pi\varepsilon_0 h}\frac{1}{n}$ $Time\ period\ \ T_n = \frac{2\pi r_n}{v_n} = \frac{4\varepsilon_0^2 h^3 n^3}{me^4}$ For first excited state of hydrogen atom n=2 $T_2 = \frac{32\varepsilon_0^2\, h^3}{me^4}$ On calculation we get $T_2 \approx 1.22\ X\ 10^{-15}\ s.$ (However, do not deduct the last ½ mark if a student does not calculate the numerical value of T_2) <u>Alternatively</u> $r_n = (\ 0.53\ n^2\ )A^0\ = 0.53\ X\ 10^{-10}\ n^2$ $v_n = (\frac{c}{137\ n})$ $T_n = \frac{2\pi(0.53)}{\left(\frac{c}{137\ n}\right)}\ X\ 10^{-10}\ n^2$ $= \frac{2\pi(0.53)}{c}\ X\ 10^{-10}\ n^3$ x 137 s $= \frac{2 \text{ x } 3.14 \text{ x } 0.53 \text{ x } 10^{-10} \text{ x } 8 \text{ x } 137}{3\ x\ 10^8}$ s $= 1215.97 \text{ x } 10^{-18}$ $= (1.22 \text{ x } 10^{-15})$ s Alternatively If the student writes directly $T_n\ \ \alpha\ \ n^3$ T_2 = 8 times of orbital period of the electron in the ground state (award one mark only)	½ ½ ½ ½ ½ ½ ½	2 2
10.	Reason 1 Expression 1 Because of line of sight nature of propagation, direct waves get blocked at some point by the curvature of earth. [Alternatively : The transmitting antenna of height h, the distance to the horizon equals d= $\sqrt{2hR}$ (R = Radius of earth, which is upto a certain distance from the TV tower] The optimum separation between the receiving and transmitting antenna. d = $\sqrt{2h_T R} + \sqrt{2h_R R}$ [Where h_T = height of Transmitting antenna (h_R = Height of Receiving antenna)]	1 1	2

11.

Reason for inability of e.m. theory	1
Resolution through photon picture	1

The explanation based on e.m theory does not agree with the experimental observations (instantaneous nature , max K.E of emitted photoelectron is independent of intensity, existence of threshold frequency) on the photoelectric effect. — 1

[Note: Do not deduct any mark if the student does not mention the relevant experimental observation or mentions any one or any two of these observation.]
The photon picture resolves this problem by saying that light, in interaction with matter behaves as if it is made of quanta or packets of energy, each of energy $h\nu$. This picture enables us to get a correct explanation of all the observed experimental features of photoelectric effect. — 1

[NOTE: Award the first mark if the student just writes "As per E.M. theory the free electrons at the surface of the metal absorb the radiant energy continuously, this leads us to conclusions which do not match with the experimental observations"]

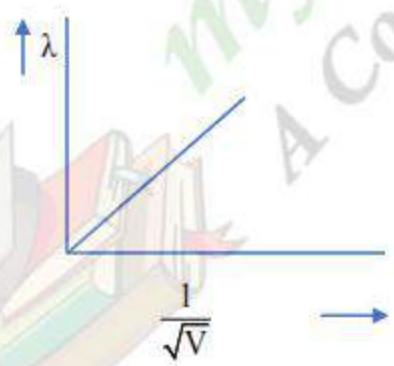
Also award the second mark if the student just writes "The photon picture give us the Einstein photoelectric equation — 2

$$K_{max} (= eV_o) = h\nu - \phi_o$$

which provides a correct explanation of the observed features of the photoelectric effect.

12.

Plot of the graph showing the variation of λ Vs $\frac{1}{\sqrt{V}}$	1
Information regarding magnitude of charge	1



— 1

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

— ½

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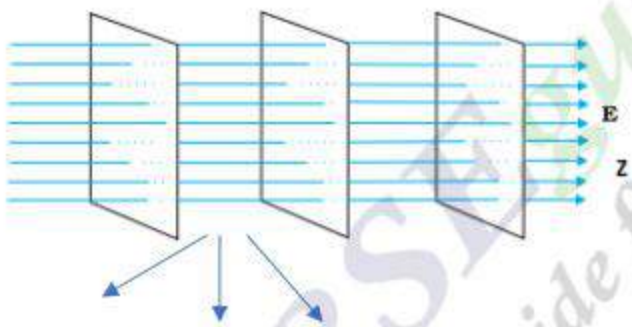
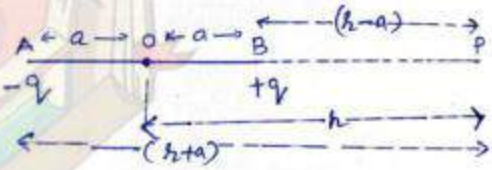
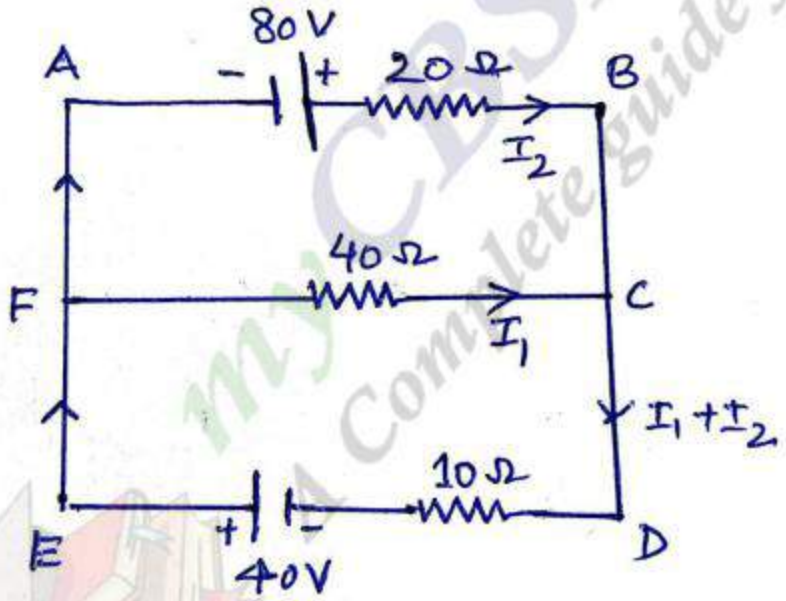
	$\frac{\lambda}{\left(\frac{1}{\sqrt{v}}\right)} = \frac{h}{\sqrt{2mq}}$ = slope $q = \frac{h^2}{2m\,(\text{slope})^2}$	½	2
	SECTION C		
13.	(a) Drawing of equipotential surfaces 1 (b) Derivation of the expression of electric potential 2  **Equipotential Surfaces** [Note : Award ½ mark if the student just writes: The equipotential surfaces are the equidistant planes perpendicular to the Z -axis and does not draw them or " The equipotential surfaces are equidistant planes parallel to the X-Y Plane".] [NOTE: In this part the Hindi version requires the student to draw equipotential surfaces for a uniform magnetic field.] **"Award this 1 mark if the student just writes that these cannot be drawn."**	1	
	(b)  Potential at point P $V_p = V_{-q} + V_{+q}$	½	

	$= \frac{1}{4\pi\epsilon_0}\frac{-q}{(r+a)} + \frac{1}{4\pi\epsilon_0}\frac{q}{(r-a)}$	½	
	$= \frac{q}{4\pi\epsilon_0}\left[\frac{1}{(r-a)} - \frac{1}{(r+a)}\right]$		
	$= \frac{q}{4\pi\epsilon_0}\left[\frac{r+a-r+a}{(r-a)(r+a)}\right]$	½	
	$= \frac{q}{4\pi\epsilon_0} \times \frac{2a}{(r^2-a^2)} = \frac{qX2a}{4\pi\varepsilon_0(r^2-a^2}$	½	
	$= \frac{1}{4\pi\epsilon_0}\frac{p}{(r^2-a^2)}$		3
	(where P is the dipole moment)		
14.			

Writing two loop equations	1 + 1
Calculation of currents through 40 Ω and 20 Ω resistors	1



In loop ABCFA

$+80 - 20\, I_2 + 40\, I_1 = 0$
$4 = I_2 - 2\, I_1$ — 1

In loop FCDEA

$-40\, I_1 - 10(I_1 + I_2) + 40 = 0$

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	$-50 I_1 - 10 I_2 + 40 = 0$ $5 I_1 + I_2 = 4$	1	
	Solving these two equations		
	$I_1 = 0A$	½	
	& $I_2 = 4A$	½	3

OR

End error, overcoming	½
Formula for meter bridge	½
Calculation of value of S	2

The end error, in a meter bridge, is the error arising due to
(i)Ends of the wire not coinciding with the 0 cm / 100 cm marks on the meter scale.

(ii)Presence of contact resistance at the joints of the meter bridge wire with the metallic strips .

It can be reduced/overcome by finding balance length with two interchanged positions of R and S and taking the average value of 'S' from two readings. ½

(Note: Award this ½ make even if student just writes only the point (i) or point (ii) given above.)

For a meter bridge

$$\frac{R}{S} = \frac{l}{100 - l}$$ ½

For the two given conditions

$$\frac{5}{S} = \frac{l_1}{100 - l_1}$$

$$\frac{5}{S/2} = \frac{1.5 l_1}{100 - 1.5 l_1}$$ ½

Dividing the two

$$2 = \frac{1.5 l_1}{(100 - 1.5 l_1)} \times \frac{(100 - l_1)}{l_1}$$ ½

$200 - 3\, l_1 = 150 - 1.5\, l_1$

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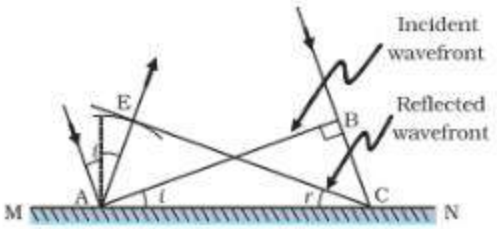
	$l_1 = \frac{100}{3}$ cm Putting the value of l_1 in any one of the two given conditions. S = 10 Ω	½ ½	3
15.	(a) Identification ½ + ½ Frequency Range ½ + ½ (b) Proof 1 Microwaves: Frequency range (~ 10^{10} to 10^{12} hz) Ultraviolet rays: Frequency range (~ 10^{15} to 10^{17} hz) Note: Award ($\frac{1}{2}+\frac{1}{2}$) marks for frequency ranges even if the student just writes the correct order of magnitude for them) (b) Average energy density of the electric field = ½ $\epsilon_0 E^2$ = ½ ϵ_0 (cB)^2 $= \frac{1}{2}\epsilon_0 \frac{1}{\mu_0 \epsilon_0} B^2$ $= \frac{1}{2}\frac{B^2}{\mu_0}$ = Average energy density of the magnetic field. [Note: Award 1 mark for this part if the student just writes the expressions for the average energy density of the electric and magnetic fields.]	½+½ ½+½ ½ ½	3
16.	Definition of the wavefront 1 Verification of the law of Reflection 2 The wave front is defined as a surface of constant phase Alternatively: The wave front is a locus of points which oscillate in phase Consider a plane wave AB incident at an angle 'I' on a reflecting surface MN	1	



1

let t = time taken by the wave front to advance from B to C.
∴ BC = vt

Let CE represent the tangent plane drawn from the point C to the sphere of radius 'vt' having A as its center.

then AE= BC= vt ½

it follows that

$\Delta\, EAC \cong \Delta BAC$

Hence $\angle i = \angle r$ ½

∴ Angle of incidence = angle of reflection

3

OR

Definition of the refractive index	1
Verification of laws of refraction	2

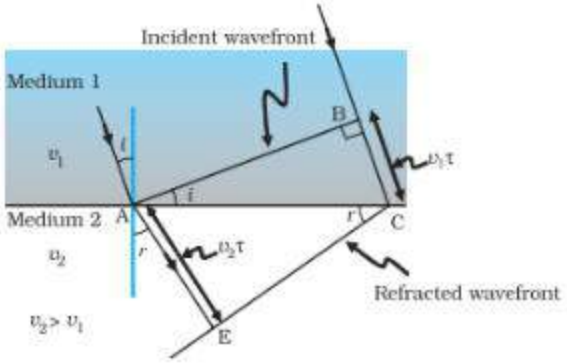
The refractive index of medium 2, w.r.t medium 1 equals the ratio of the sine of angle of incidence (in medium 1) to the sine of angle of refraction (in medium 2)

Alternatively:
Refractive index of radium 2 w.r.t medium 1

$$n_{21} = \frac{\sin i}{\sin r}$$

Alternatively : Refractive index of medium 2 w.r.t medium 1 1

$$n_{21} = \frac{\text{Velcoity of light in medium 1}}{\text{Velocity of light in medium 2}}$$



1

The figure drawn here shows the refracted wave front corresponding to the given incident wave front.

It is seen that

$$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$$ ½

$$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$$

$$\therefore \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \mu_{21}$$ ½

This is Snell's law of refraction. 3

17.

(a) Definition of mutual inductance and S.I unit	1+½
(b) Obtaining the expression for resultant force on the loop	1½

(a) Mutual inductance equals the magnetic flux associated with a coil when unit current flows in its neighbouring coil.

Alternatively: Mutual inductance equals the induced emf in a coil when the rate of change of current in its neighbouring coil is one ampere/ second. 1

S.I unit : henry (H) or weber/ampere (or any other correct SI unit) ½

(b) Force per unit length between two parallel straight conductors

$$F = \frac{\mu_0}{4\pi}\frac{2I_1I_2}{d}$$

Force on the part of the loop which is parallel to infinte straight wire and at a distance x from it.

$$F_1 = \frac{\mu_0}{2\pi}\frac{I_1 I_2\ a}{x}$$ (away from the infinte straight wire) ½

Force on the part of the loop which is at a distance (x + a) from it

$$F_2 = \frac{\mu_0}{2\pi}\frac{I_1 I_2\ a}{(x\ +\ a)}$$ (towards the infinte straight wire) ½

Net force $F = F_1 - F_2$

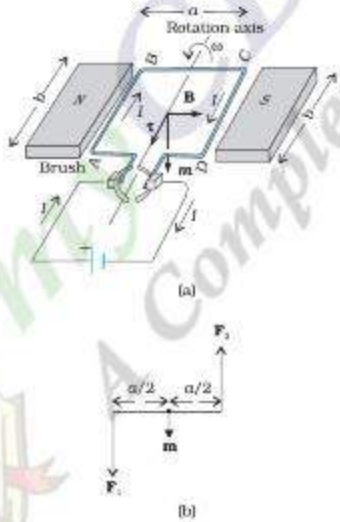
$$F = \frac{\mu_0}{2\pi}\frac{I_1 I_2\ a}{}\left[\frac{1}{x} - \frac{1}{x+a}\right]$$

$$F = \frac{\mu_0}{2\pi}\frac{I_1 I_2\ a^2}{x\ (x\ +\ a)}$$ (away from the infinte straight wire) ½ 3

18.

(a) Derivation of the expression for torque	2
(b) Significance of radial magnetic field	1

(a) Consider the simple case when a rectangular loop is placed in a uniform magnetic field B that is in the plane of the loop

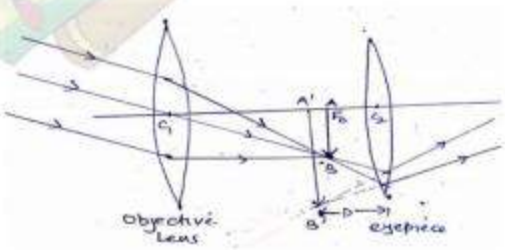


½

Force on arm AB = F_1 = IbB (directed into the plane of the loop)
Force on arm CD = F_2= IbB (directed out of the plane of the loop) ½

Therefore the magnitude of the torque on the loop due to these pair of forces

$$\tau = F_1\frac{a}{2} + F_2\frac{a}{2}$$ ½

	= I (ab) B = IAB = mB (A = ab = area of the loop) <u>Alternatively</u> Also accept if the student does calculations for the general case and obtains the result Torque = IAB sin ϕ Alternatively Also accept if the student says that the euivalent magnetic moment $\vec{m}$ (m),associated with a current carrying loop is $\vec{m}$=IA $\hat{n}$ (A = Area of loop) The torque, on a magnetic dipole, in a magnetic field, is given by $\vec{\tau} = \vec{m} \times \vec{B}$ $\therefore \quad \tau = I A (\hat{n} \times \vec{B})$ Hence Magnitude of torque is = IAB sin ϕ (b) When a current carrying coil is kept in a radial magnetic field the corresponding moving coil galvanometer would have a linear scale Alternatively " In a radial magnetic field two sides of the rectangular coil remain parallel to the magnetic field lines while its other two sides remain perpendicular to the magnetic field lines. This holds for all positions of the coil."	½ ½ 1	3
19.	Labelled ray diagram of an astronomical telescope 1 ½ Calculation of the diameter of the image of the moon. 1½  	1½	

[Note: (i) Deduct ½ mark If arrows are not shown.
(ii) Award one mark of this part if a student draws the ray diagram for normal Adjustment / relaxed eye.]

Angular magnification of the telescope = $\frac{f_o}{f_e} = \frac{15}{0.01} = 1500$ ½

For objective lens, $\tan\alpha = \frac{3.48X\,10^6}{3.8X10^8}$ 3

For eyepiece $\tan\beta = \frac{h_i}{f_e} = \frac{h_i}{10^{-2}}$ ½

$\therefore$ Magnifying power $= \frac{\beta}{\alpha} = \frac{\frac{h_i}{10^{-2}}}{\frac{3.48\,X10^6}{3.8\,X\,10^8}}$

$= \frac{h_i X3.8X10^8}{3.48X10^6X10^{-2}} = 1500$

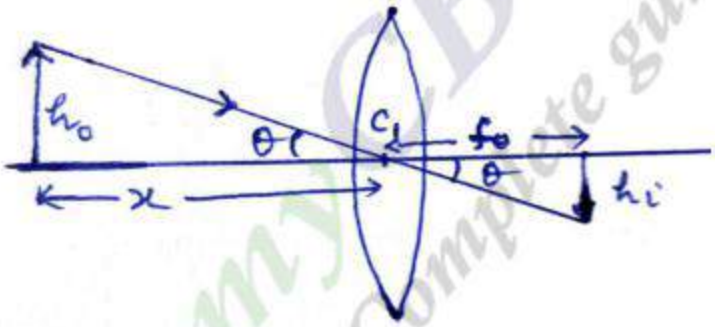
h_i = 13.73 cm ½

Also accept angular magnification of the telescope

$= \frac{f_o}{f_e}\left(1 + \frac{f_e}{d}\right) = \frac{15}{0.01}\left(1 + \frac{0.01}{0.25}\right) = 1560$

So, h_i = 14.29 cm

Alternatively



½

From figure:

$\frac{h_o}{x} = \frac{h_i}{f_o}$ [Where h_o and h_i are the diameter of the moon and diameter of the image of the moon respectively.] ½

$h_i = \frac{h_o f_o}{x}$ ½

$= \frac{3.48\times10^6}{3.8\times10^8}\times15$

= 13.73cm ½ 3

20.

(a)statement of Gauss's law in magnetism	½
Its significance	½
(b)Four Important properties	½ x4

(a) Gauss's law for magnetism states that "The total flux of the magnetic field, through any closed surface, is always zero. ½

Alternatively

$$=\oint_s \vec{B}.\vec{d}s = 0$$

This law implies that magnetic monopoles do not exist" / magnetic field lines form closed loops ½

[Note: Award this I mark if the student just attempts it]

(b) Four properties of magnetic field lines ½

(i) Magnetic field lines always form continuous closed loops.

(ii) The tangent to the magnetic field line at a given point represents the direction of the net magnetic field at that point. ½

(iii) The larger the number of field lines crossing per unit area, the stronger is the magnitude of the magnetic field. ½

(iv) Magnetic field lines do not intersect. ½

OR

Three points of difference	3 x ½
One example of each	1½

	Diamagnetic	Paramagnetic	Ferromagnetic	
1	$-1 \le \chi \langle 0$	$-0 \langle \chi \langle \varepsilon$	$\chi \rangle\rangle 1$	½
2	$0 \le \mu_r \langle 1$	$1 \le \mu_r \langle 1+\varepsilon)$	$\mu_r \rangle\rangle 1$	½
3	$\mu \langle \mu_0$	$\mu \rangle \mu_0$	$\mu \rangle\rangle \mu_0$	½

Where ε is any positive constant.

[Note: Give full credit of this part if student write any other three correct difference]

Examples (Any one example of each type)

Diamagnetic materials: Bi,Cu, Pb,Si, water, NaCl, Nitrogen (at STP) ½

Paramagnetic materials: Al,Na,Ca, Oxygen(at STP), Copper chloride ½

Ferromagnetic materials: Fe,Ni,Co,AlniCo ½ 3

21.

Definition of decay constant	1
Calculation of half life	1
Calculation of initial number of nuclei at t=0	1

The decay constant (λ) of a radioactive nucleus equals the ratio of the instantaneous rate of decay $(\frac{\Delta N}{\Delta t})$ to the corresponding instantaneous number of radioactive nuclei. 3

Alternatively:

The decay constant (λ) of a radioactive nucleus is the constant of proportionality in the relation between its rate of decay and number of its nuclei at any given instant.

Alternatively:

$$\frac{\Delta N}{\Delta t} \propto N$$

$$\frac{\Delta N}{\Delta t} = \lambda N$$

The constant (λ) is known as the decay constant

Alternatively:

The decay constant equals the reciprocal of the mean life of a given radioactive nucleus .

$$\lambda = \frac{1}{\tau}$$

where

τ= mean life

Alternatively:

The decay constant equal the ratio of $\ln_e 2$ to the half life of the given radioactive element.

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

Where $T_{1/2}$ = Half life 1

Alternatively:

The decay constant of a radioactive element, is the reciprocal of the time in which the number of its nuclei reduces to 1/e of its original number.

(Note: Do not deduct any mark of this definition, if a student does not write the formula in support of the definition)

We have ½

$$R = \lambda N$$

	R (20 hrs) = 10000 = λN_{20} R (30 hrs) = 5000 = λN_{30} $\therefore \quad \frac{N_{20}}{N_{30}} = 2$ This means that the number of nuclei, of the given radioactive nucleus, gets halved in a time of (30 - 20) hours = 10 hours $\therefore$ Half life = 10 hours This means that in 20 hours (= 2 half lives), the original number of nuclei must have gone down by a factor of 4. Hence Rate of decay at t = 0 $\lambda N_0 = 4\lambda N_{20}$ =4X10000 = 40,000 disintegration per second (Note : Award full marks of the last part of this question even if student does not calculate initial number of nuclei and calculates correctly rate of disintegration at t=0) i.e R_0 = 40,000 disintegration per second $N_0 = \frac{40000}{\lambda} = \frac{40000}{\ln_e 2} \times 10 \times 60 \times 60$ $N_0 = \frac{144 \times 10^7}{0.693} = 2.08 \times 10^9 \ nuclei$	½ ½ ½	3
22.	(a) Calculation of energy of a photon of light 1½ (b) Identification of photodiode 1½ Why photodiode are operated in reverse bias 1 We have $E = h\nu = \frac{hc}{\lambda}$ $= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{600 \times 10^{-9}}$ J	½ ½	

$$= \frac{19.89 \times 10^{-26}}{6\times10^{-7} \times 1.6\times10^{-19}} \text{ eV}$$

$$= \frac{19.89}{9.6} \text{ eV}$$ ½

= 2.08eV

The band gap energy of diode D_2 (= 2eV) is less than the energy of the photon. Hence diode D_2 will not be able to detect light of wavelength 600 nm. ½

[Note: Some student may take the energy of the photon as 2eV and say that all the three diodes will be able is detect this right , Award them the ½ mark for the last part of identification]

(b) A photodiode when operated in reverse bias, can measure the fractional change in minority carrier dominated reverse bias current with greater ease 1
Alternatively: It is easier is observe the change in current with change in light intensity , if a reverse bias is applied

3

23.

(a) Functions of the three segments $\frac{1}{2}+\frac{1}{2}+\frac{1}{2}$

(b) Circuit diagram for studying the output characteristics 1

obtaining output characteristics ½

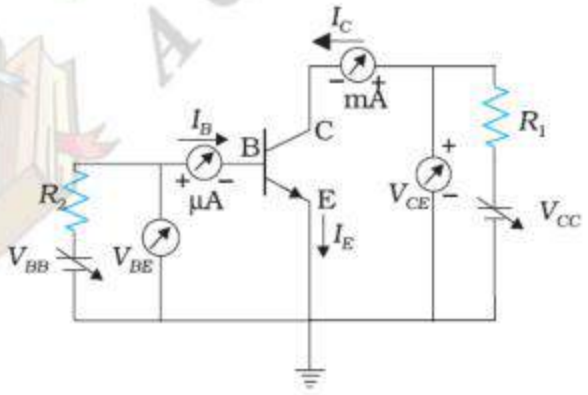
(i) Emitter : supplies the large number of majority carriers for current flow through the transistor ½

(ii) Base: Allows most of the majority charge carriers to go over to the collector ½

Alternatively , It is the very thin lightly doped central segment of the transistor.

Collector : collects a major portion of the majority charge carriers supplied by the emitter. ½

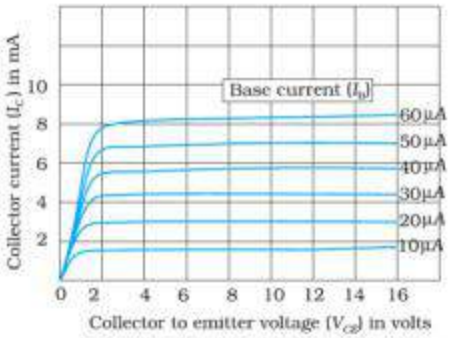
(b)



1

The output characteristics are obtained by observing the variation of I_c when V_{CE} is varied keeping I_B constant . ½

Note:Award the last ½ mark even if the student just draws the graph for output characteristics



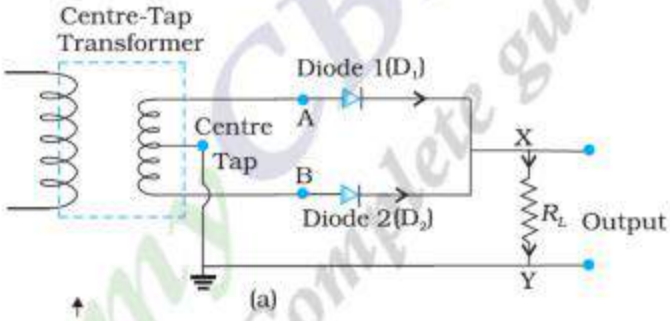
(b)

[Note: Do not deduct marks of this part, for not writing values on the axis]

OR

Circuit diagram of full wave rectifier	½
working	½
Input and output wave forms	½ + ½

The circuit diagram of a full wave rectifier is shown below.

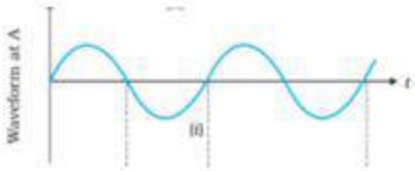


1

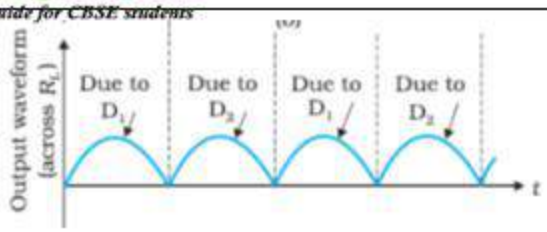
Because of the center tap in the secondary of the transformer, diodes 1 and 2 get forward biased in successive halves of the input ac cycle. However the current through the load flows in the same direction in both the halves of he input ac cycle. We therefore, get a unidirectional (rectified) current through the load for the full cycle of the input ac.

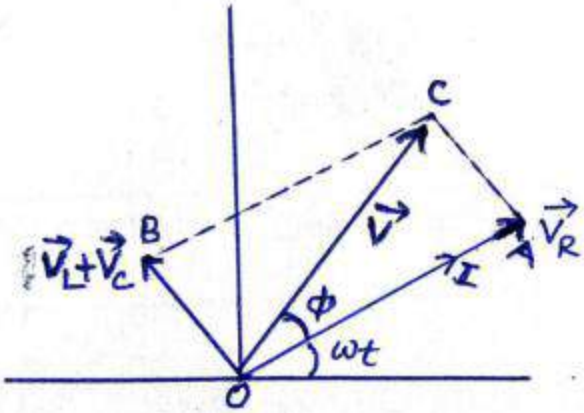
1

The input and output wave forms are as shown below.



½

		½	3
24.	(a)Obtaining the expression for modulation index in terms of A and B 1 ½ (b) calculation of μ 1 Reason ½ We are given that $A = A_c + A_m$ and $B = A_c - A_m$ $A_c = (A + B)/2$ $A_m = (A - B)/2$ $\therefore \quad \mu = \frac{A_m}{A_c}$ $= \frac{A-B}{A+B}$ (b) We have $\mu = \frac{A_m}{A_c}$ $= \frac{10}{15} = 2/3$ μ is kept less than one to avoid distortion	½ ½ ½ ½ ½ ½	3
	SECTION D		
25.	(a) Derivation of the expression for impedance 2 plot of impedance with frequency ½ b) Phase difference between voltage across inductor and capacitor ½ (c) Reason and calculation of self induction $\frac{1}{2}+1\frac{1}{2}$		



1

$|\vec{V}|=V_m$

$|V_R|=V_{Rm}$

$|V_L|=V_{Lm}$

From the figure, the pythagorean theorem gives

$V_m^2 = V_{Rm}^2 + (V_{Lm} - V_{cm})^2$

$V_{Rm} = i_m R$, $V_{Lm} = i_m X_L$, $V_{cm} = i_m X_c$,

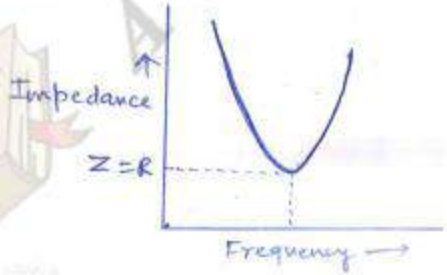
$V_m = i_m Z$ ½

$= (i_m Z)^2 = (I_m R)^2 + (i_m X_L - i_m X_c)$

$z^2 = R^2 + ((X_L - X_c)^2$

$\therefore z = \sqrt{R^2 + (X_L - X_c)^2}$

[note: award these two marks, if a student does it correctly for the other case i.e ($V_c > V_L$)] ½



½

(b) Phase difference between voltage across inductor and the capacitor at resonance is 180° ½

(c) Inductor will offer an additional impedance to ac due to its self inductance. ½

R= $\frac{V_{rm}}{I_{rms}} = \frac{200}{1} = 200\ \Omega$

Impedance of the inductor

Z= $\frac{V_{rms}}{I_{rms}} = \frac{200}{0.5} = 400\ \Omega$ ½

Since Z= $\sqrt{R^2 + (X_L)^2}$

$\therefore (400)^2 - (200)^2 = (X_L)^2$

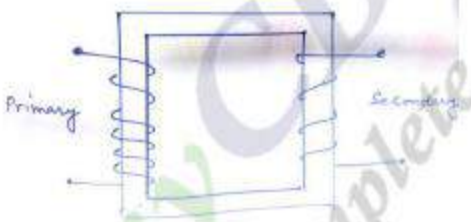
$X_L = \sqrt{600X200} = 346.4\ \Omega$ ½

Inductance (L) = $\frac{X_L}{w} = \frac{364.4}{2X3.14X\ 50} = 1.1H$ ½

OR

(a) Diagram of the device	1
working Principle	½
Four sources of energy loss	$\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}$
(b) Estimation of Line power loss	1½

(a)



1

Working Principle : When the alternating voltage is applied to the primary , the resulting current produces an alternating magnetic flux in secondary and induces an emf in it./It works on the mutual induction. ½

Four sources of energy loss

(i) Flux leakage between primary and secondary windings ½

(ii) Resistance of the windings ½

(iii)Production of eddy currents in the iron core. ½

(iv)Magnetization of the core. ½

(b) Total resistance of the line = length X resistance per unit length

= 40 km x 0.5 Ω/km

= 20 Ω ½

	Current flowing in the line I = P/V $I = \frac{1200 \times 10^3}{4000}$ = 300A $\therefore$ *Line power loss in the form of heat* P=I^2 R =$((300)^2$ x 20 = 1800 kW	½ ½	5
26.	(a) ~~Two characteristic~~Two characteristic features of distinction ___2 ~~Dervation~~Derivation of the expression for the intensity $1\frac{1}{2}$ (b) Calculation of separation between the first order (a) (Any two of the following) (i) Interference pattern has number of equally spaced bright and dark bands while diffraction pattern has central bright maximum which is twice as wide as the other maxima. (ii) Interference is obtained by the superposing two waves originating from two narrow slits. The diffraction pattern is the superposition of the continuous family of waves originating from each point on a single slit. (iii) In interference pattern, the intensity of all bright fringes is same, while in diffraction pattern intensity of bright fringes go on decreasing with the increasing order of the maxima (iv)In interference pattern , the first maximum falls at an angle of $\frac{\lambda}{a}$. where a is the separation between two narrow slits, while in diffraction pattern, at the same angle first minimum occurs. (where 'a' is the width of single slit.) Displacement produced by source s_1 Y_1 = a cos wt Displacement produced by the other source 's_2' Y_2= a cos (wt + Ø) Resultant displacement Y = $Y_1 + Y_2$ = a [cos wt + cos (wt + Ø) = 2a cos ($Ø/2$) cos (wt + $Ø/2$) Amplitude of resultant wave A= 2a cos ($Ø/2$) Intensity I α A^2 I= KA^2= K 4 $a^2 cos^2$ ($\frac{Ø}{2}$)	½ + ½ ½ + ½ ½ ½ ½	

(a) Distance of First order minima from centre of the central maxima = ½

$x_{D1}=\frac{\lambda D}{a}$

Distance of third order maxima from centre of the central maxima

$X_{B3}=\frac{7D\lambda}{2a}$

∴ Distance between first order minima and third order maxima= $x_{B3} - x_{d1}$

$$=\frac{7D\lambda}{2a}-\frac{\lambda D}{a}$$

½

$$=\frac{5D\lambda}{2a}$$

$$=\frac{5\ X\ 620\ X\ 10^{-9}\ X\ 1.5}{2X3X10^{-3}}$$

½

$=775 \text{ X } 10^{-6}$m

$=7.75 \text{ X } 10^{-4}$m

OR

(a) Two conditions of total internal reflection	1 +1
(b) Obtaining the relation	1
(c) Calculating of the position of the final image	2

(a) (i) Light travels from denser to rarer medium. 1

(ii) Angle of incidence is more than the critical angle 1

For the Grazing incidence

μ sin i_c = 1 sin 90° ½

μ = $\frac{1}{sini_c}$ ½

(b) For convex lens of focal Length 10 cm

$\frac{1}{f_1}=\frac{1}{v_1}-\frac{1}{u_1}$ ½

$\frac{1}{10}=\frac{1}{v_1}-\frac{1}{-30}$ => v_1 = 15 cm ½

Object distance for concave lens u_2= 15-5 =10 cm

$$\frac{1}{f_2}=\frac{1}{v_2}-\frac{1}{u_2}$$

$$\frac{1}{-10}=\frac{1}{v_2}-\frac{1}{10}$$

$v_2 = \infty$ ½

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For third lens

$$\frac{1}{f_3} = \frac{1}{v_3} - \frac{1}{u_3}$$

$$\frac{1}{3_{\circ}} = \frac{1}{v_3} - \frac{1}{\infty} => v_3 = 30\ cm$$

½ | 5

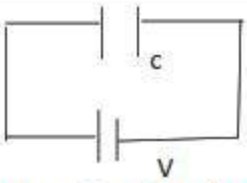
27.

a) Description of the process of transferring the charge. $\frac{1}{2}$

Derivation of the expression of the energy stored $2\frac{1}{2}$

b) Calculation of the ratio of energy stored 2

(a)



The electrons are transferred to the positive terminal of the battery from the metallic plate connected to the positive terminal, leaving behind positive charge on it. Similarly, the electrons move on to the second plate from negative terminal, hence it gets negatively charged. Process continuous till the potential difference between two plates equals the potential of the battery. ½

[Note: award this $\frac{1}{2}$ mark, If the student writes, there will be no transfer of charge between the plates]

Let 'dw' be the work done by the battery in increasing the charge on the capacitor from q to (q+ dq).

$$dW = V\,dq$$ ½

Where $V = \frac{q}{c}$ ½

$\therefore dW = \frac{q}{c} dq$ ½

Total work done in changing up the capacitor

$$W = \int dw = \int_0^Q \frac{q}{c} dq$$ ½

$\therefore W = \frac{Q^2}{2C}$

Hence energy stored = $W = \frac{Q^2}{2C}$ $(= \frac{1}{2} CV^2 = \frac{1}{2} QV)$ ½

(b) Charge stored on the capacitor q=CV

When it is connected to the uncharged capacitor of same capacitance, sharing of charge takes place between the two capacitor till the potential of both the capacitor becomes $\frac{V}{2}$ ½

Energy stored on the combination $(u_2) = \frac{1}{2} C \left(\frac{V}{2}\right)^2 + \frac{1}{2} C \left(\frac{V}{2}\right)^2 = \frac{CV^2}{4}$ ½

Energy stored on single capacitor before connecting ½

$U_1 = \frac{1}{2} CV^2$

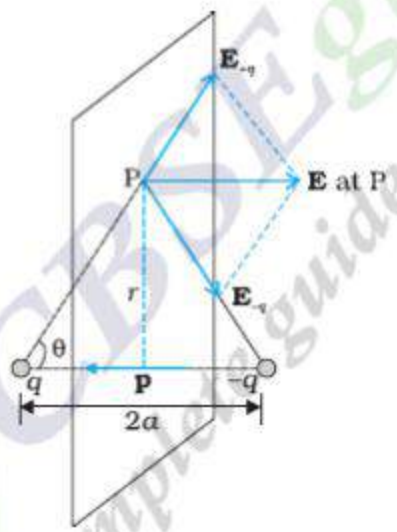
Ratio of energy stored in the combination to that in the single capacitor

$\frac{U_2}{U_1} = \frac{CV^2/4}{CV^2/2} = 1:2$ ½

OR

(a)	Derivation for the expression of the electric field on the equatorial line	3
(b)	Finding the position and nature of Q	1 + 1

(a)



1

The magnitude of the electric fields due to the two charges +q and -q are

$$E_{+q} = \frac{1}{4\pi \in_0} \frac{q}{(r^2 + a^2)}$$ ½

$$E_{-q} = \frac{1}{4\pi \in_0} \frac{q}{(r^2 + a^2)}$$ ½

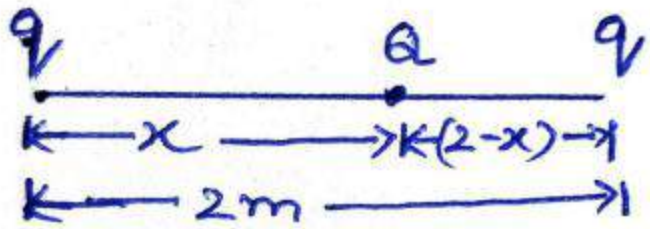
5

The components normal to the dipole axis cancel away and the components along the dipole axis add up

Hence total Electric field = - $(E_{+q} + E_{-q})\cos\theta \ \hat{p}$ ½

$$E = -\frac{2qa}{4\pi\varepsilon_0\left(r^2+a^2\right)^{3/2}}\,\vec{p}$$ ½

(b)



½

System is in equilibrium therefore net force on each charge of system will be zero.

For the total force on 'Q' to be zero

$$\frac{1}{4\pi\in_0}\frac{qQ}{x^2}=\frac{1}{4\pi\in_0}\frac{qQ}{(2-x)^2}$$ ½

x = 2 – x

2x = 2
x = 1 m ½

(Give full credit of this part, if a students writes directly 1m by observing the given condition)

For the equilibrium of charge "q" the nature of charge Q must be opposite to the nature of charge q. ½ 5

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SET-1

Series BVM/2

कोड नं.
Code No. **55/2/1**

रोल नं.
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 **19** 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 **27** 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 जाएगा । 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 **19** 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 **27** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minute 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 घण्टे — *अधिकतम अंक : 70*

Time allowed : 3 hours — *Maximum Marks : 70*

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सामान्य निर्देश :

(i) **सभी** प्रश्न अनिवार्य हैं । इस प्रश्न-पत्र में कुल **27** प्रश्न हैं ।

(ii) इस प्रश्न-पत्र के **चार** भाग हैं : खण्ड अ, खण्ड ब, खण्ड स और खण्ड द ।

(iii) खण्ड अ में **पाँच** प्रश्न हैं, प्रत्येक का **एक** अंक है । खण्ड ब में **सात** प्रश्न हैं, प्रत्येक के **दो** अंक हैं । खण्ड स में **बारह** प्रश्न हैं, प्रत्येक के **तीन** अंक हैं और खण्ड द में **तीन** प्रश्न हैं, प्रत्येक के **पाँच** अंक हैं ।

(iv) प्रश्न-पत्र में समग्र पर कोई विकल्प नहीं है । तथापि, **एक** अंक वाले **दो** प्रश्नों में, **दो** अंकों वाले **दो** प्रश्नों में, **तीन** अंकों वाले **चार** प्रश्नों में और **पाँच** अंकों वाले **तीनों** प्रश्नों में आन्तरिक चयन प्रदान किया गया है । ऐसे प्रश्नों में आपको दिए गए चयन में से केवल **एक** प्रश्न ही करना है ।

(v) जहाँ आवश्यक हो, आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :

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

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

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

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

इलेक्ट्रॉन का द्रव्यमान $(m_e) = 9{\cdot}1 \times 10^{-31}$ kg

न्यूट्रॉन का द्रव्यमान $= 1{\cdot}675 \times 10^{-27}$ kg

प्रोटॉन का द्रव्यमान $= 1{\cdot}673 \times 10^{-27}$ kg

आवोगाद्रो संख्या $= 6{\cdot}023 \times 10^{23}$ प्रति ग्राम मोल

बोल्ट्ज़मान नियतांक $= 1{\cdot}38 \times 10^{-23}$ JK^{-1}

General Instructions :

(i) ***All*** *questions are compulsory. There are* ***27*** *questions in all.*

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

(iii) *Section A contains* ***five*** *questions of* ***one*** *mark each, Section B contains* ***seven*** *questions of* ***two*** *marks each, Section C contains* ***twelve*** *questions of* ***three*** *marks each, Section D contains* ***three*** *questions of* ***five*** *marks each.*

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(iv) *There is no overall choice. However, an internal choice(s) has been provided in* ***two*** *questions of* ***one*** *mark,* ***two*** *questions of* ***two*** *marks,* ***four*** *questions of* ***three*** *marks and* ***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 :*

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

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

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

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (m_e) = $9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

खण्ड अ

SECTION A

1. किसी वैद्युत द्विध्रुव के लिए समविभव पृष्ठ खींचिए । *1*

Draw equipotential surfaces for an electric dipole.

2. किसी प्रोटॉन को उसके वेग की दिशा के अभिलम्बवत् एकसमान चुम्बकीय क्षेत्र में प्रवेश कराने से पूर्व विभवान्तर V तक त्वरित किया गया । यदि विभवान्तर को दुगुना कर दिया जाए, तो चुम्बकीय क्षेत्र में प्रोटॉन द्वारा चले गए वृत्ताकार पथ की त्रिज्या किस प्रकार परिवर्तित होगी ? *1*

A proton is accelerated through a potential difference V, subjected to a uniform magnetic field acting normal to the velocity of the proton. If the potential difference is doubled, how will the radius of the circular path described by the proton in the magnetic field change ?

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3. 300 K ताप पर मैग्नीशियम की चुम्बकीय प्रवृत्ति $1{\cdot}2 \times 10^5$ है । किस ताप पर इसकी चुम्बकीय प्रवृत्ति $1{\cdot}44 \times 10^5$ हो जाएगी ? *1*

अथवा

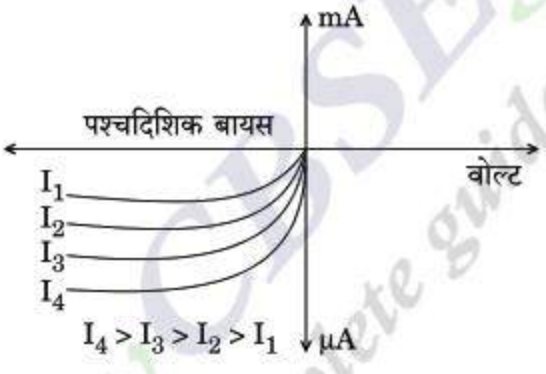
किसी दिए गए पदार्थ की चुम्बकीय प्रवृत्ति $\chi - 0{\cdot}5$ है । इस चुम्बकीय पदार्थ को पहचानिए । *1*

The magnetic susceptibility of magnesium at 300 K is $1{\cdot}2 \times 10^5$. At what temperature will its magnetic susceptibility become $1{\cdot}44 \times 10^5$?

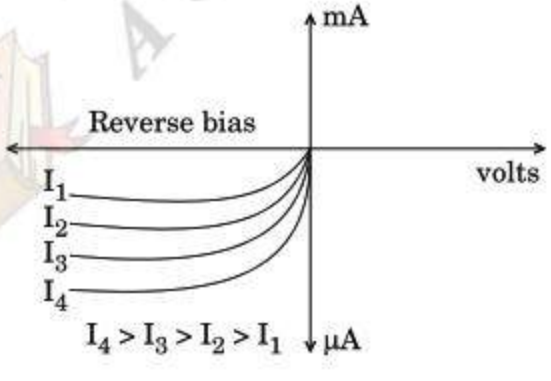
OR

The magnetic susceptibility χ of a given material is $-0{\cdot}5$. Identify the magnetic material.

4. उस अर्धचालक डायोड को पहचानिए जिसके V-I अभिलाक्षणिक आरेख में दर्शाए अनुसार हैं । *1*



Identify the semiconductor diode whose V-I characteristics are as shown.



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5. रेडार में विद्युत्-चुम्बकीय स्पेक्ट्रम के किस भाग का उपयोग किया जाता है ? इसका आवृत्ति-परिसर लिखिए । *1*

अथवा

त्वरित होते आवेशों द्वारा विद्युत्-चुम्बकीय तरंगें किस प्रकार उत्पन्न की जाती हैं ? *1*

Which part of the electromagnetic spectrum is used in RADAR ? Give its frequency range.

OR

How are electromagnetic waves produced by accelerating charges ?

खण्ड ब
SECTION B

6. क्षेत्रफल 'A' की पट्टिकाओं से बने दो समान्तर पट्टिका संधारित्र, जिनके बीच पृथकन 'd' है, को किसी बाह्य dc स्रोत द्वारा आवेशित किया गया है । यह दर्शाइए कि आवेशित करते समय संधारित्र के भीतर विस्थापन धारा, संधारित्र को आवेशित करने वाली धारा के समान ही होती है । *2*

A capacitor made of two parallel plates, each of area 'A' and separation 'd' is charged by an external dc source. Show that during charging, the displacement current inside the capacitor is the same as the current charging the capacitor.

7. किसी फ़ोटॉन और किसी प्रोटॉन की दे-ब्रॉग्ली तरंगदैर्घ्य λ समान है । सिद्ध कीजिए कि फ़ोटॉन की ऊर्जा प्रोटॉन की गतिज ऊर्जा की $(2m\lambda c/h)$ गुनी है । *2*

A photon and a proton have the same de-Broglie wavelength λ. Prove that the energy of the photon is $(2m\lambda c/h)$ times the kinetic energy of the proton.

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8. किसी हाइड्रोजन परमाणु में किसी इलेक्ट्रॉन को अवस्था n से पहली उत्तेजित अवस्था तक व्युत्तेजित करते समय उत्सर्जित कोई फ़ोटॉन 0·55 V के निरोधी विभव वाले प्रकाश विद्युत् सेल में 2 eV कार्यफलन के धात्विक कैथोड को किरणित करता है । अवस्था n की क्वान्टम संख्या का मान प्राप्त कीजिए । 2

अथवा

12·5 eV ऊर्जा के किसी इलेक्ट्रॉन पुंज द्वारा किसी हाइड्रोजन परमाणु को उसकी निम्नतम अवस्था से उत्तेजित किया गया है । इस उत्तेजित अवस्था से परमाणु द्वारा उत्सर्जित लाइनों की अधिकतम संख्या ज्ञात कीजिए । 2

A photon emitted during the de-excitation of electron from a state n to the first excited state in a hydrogen atom, irradiates a metallic cathode of work function 2 eV, in a photo cell, with a stopping potential of 0·55 V. Obtain the value of the quantum number of the state n.

OR

A hydrogen atom in the ground state is excited by an electron beam of 12·5 eV energy. Find out the maximum number of lines emitted by the atom from its excited state.

9. सामान्य समायोजन की स्थिति में किसी खगोलीय दूरबीन (दूरदर्शक) द्वारा प्रतिबिम्ब बनना दर्शाने के लिए किरण आरेख खींचिए । इसकी आवर्धन क्षमता के लिए व्यंजक लिखिए । 2

अथवा

किसी संयुक्त सूक्ष्मदर्शी द्वारा प्रतिबिम्ब बनना दर्शाने के लिए नामांकित किरण आरेख खींचिए और इसकी विभेदन क्षमता के लिए व्यंजक लिखिए । 2

Draw the ray diagram of an astronomical telescope showing image formation in the normal adjustment position. Write the expression for its magnifying power.

OR

Draw a labelled ray diagram to show image formation by a compound microscope and write the expression for its resolving power.

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10. किसी TV एन्टीना की ऊँचाई और उस एन्टीना द्वारा प्रेषित सिग्नलों के अधिकतम परिसर जिसमें उस सिग्नल को प्राप्त किया जा सकता है, के बीच संबंध लिखिए । दृष्टरेखीय संचार के प्रकरण में व्योम तरंगों के लिए इस व्यंजक को किस प्रकार संशोधित किया जाता है ? आवृत्तियों के किस परिसर में संचार की इस विधा का उपयोग किया जाता है ? 2

Write the relation between the height of a TV antenna and the maximum range up to which signals transmitted by the antenna can be received. How is this expression modified in the case of line of sight communication by space waves ? In which range of frequencies, is this mode of communication used ?

11. किन परिस्थितियों में इन्द्रधनुष का प्रेक्षण किया जा सकता है ? प्राथमिक एवं द्वितीयक इन्द्रधनुषों के बीच विभेदन कीजिए । 2

Under which conditions can a rainbow be observed ? Distinguish between a primary and a secondary rainbow.

12. निम्नलिखित की व्याख्या कीजिए : 2

(a) आकाश का नीला प्रतीत होना ।

(b) (i) सूर्यास्त एवं (ii) सूर्योदय के समय सूर्य का रक्ताभ प्रतीत होना ।

Explain the following :

(a) Sky appears blue.

(b) The Sun appears reddish at (i) sunset, (ii) sunrise.

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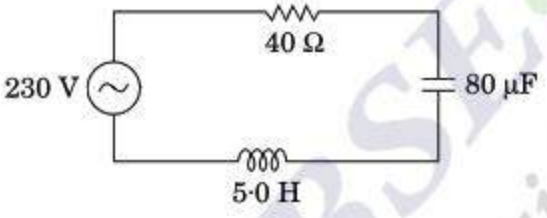
खण्ड स

SECTION C

13. 50 Hz आवृत्ति के किसी ac वोल्टता स्रोत के साथ श्रेणी में कोई संधारित्र (C) और प्रतिरोधक (R) संयोजित हैं । C और R के सिरों पर विभवान्तर क्रमश: 120 V और 90 V है, तथा परिपथ में प्रवाहित धारा 3 A है । (i) परिपथ की प्रतिबाधा तथा (ii) प्रेरकत्व का वह मान परिकलित कीजिए जिसे C और R के साथ श्रेणी में संयोजित करने पर परिपथ का शक्ति गुणांक 'एक' हो जाता है । *3*

अथवा

आरेख में परिवर्ती आवृत्ति के 230 V के स्रोत के साथ श्रेणी LCR परिपथ दर्शाया गया है । *3*



(a) परिपथ को अनुनाद में प्रचालित करने वाली स्रोत आवृत्ति निर्धारित कीजिए ।

(b) अनुनाद की स्थिति में परिपथ की प्रतिबाधा और धारा का आयाम परिकलित कीजिए ।

(c) यह दर्शाइए कि अनुनाद आवृत्ति पर LC संयोजन के सिरों पर विभव पात शून्य होता है ।

A capacitor (C) and resistor (R) are connected in series with an ac source of voltage of frequency 50 Hz. The potential difference across C and R are respectively 120 V, 90 V, and the current in the circuit is 3 A. Calculate (i) the impedance of the circuit (ii) the value of the inductance, which when connected in series with C and R will make the power factor of the circuit unity.

OR

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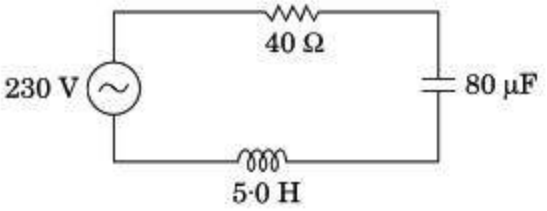
The figure shows a series LCR circuit connected to a variable frequency 230 V source.

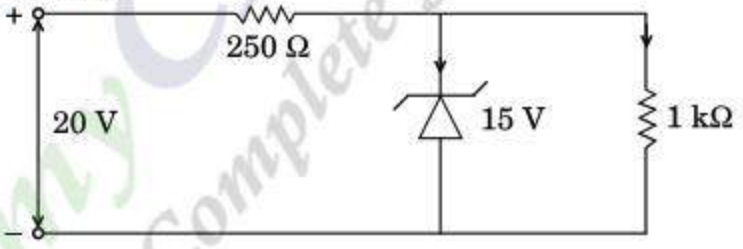


(a) Determine the source frequency which drives the circuit in resonance.

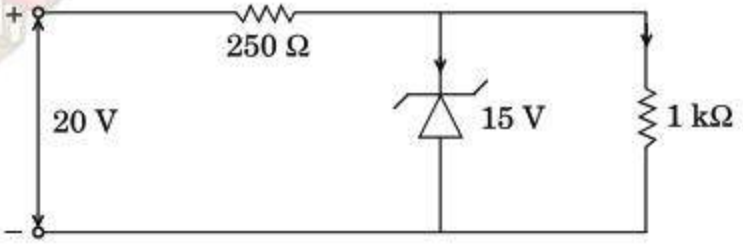
(b) Calculate the impedance of the circuit and amplitude of current at resonance.

(c) Show that potential drop across LC combination is zero at resonating frequency.

14. ज़ेनर डायोड के n और p क्षेत्रों को अत्यधिक मादित किए जाने की व्याख्या करने के लिए कारण दीजिए । नीचे दिए गए परिपथ में ज़ेनर डायोड से प्रवाहित धारा ज्ञात कीजिए : (ज़ेनर भंजन वोल्टता 15 V है) *3*



Give reason to explain why n and p regions of a Zener diode are heavily doped. Find the current through the Zener diode in the circuit given below : (Zener breakdown voltage is 15 V)



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15. साइक्लोट्रॉन का नामांकित आरेख खींचिए । इसके कार्यकारी सिद्धान्त की व्याख्या कीजिए । यह दर्शाइए कि साइक्लोट्रॉन आवृत्ति चाल और कक्षा की त्रिज्या पर निर्भर नहीं करती । *3*

अथवा

(a) आरेख की सहायता से किसी अत्यधिक लम्बी धारावाही परिनालिका, जिसमें फेरों की संख्या n फेरे प्रति एकांक लम्बाई है तथा धारा I प्रवाहित हो रही है, के भीतर चुम्बकीय क्षेत्र के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) टोरॉइड परिनालिका से किस प्रकार भिन्न होता है ? *3*

Draw a labelled diagram of cyclotron. Explain its working principle. Show that cyclotron frequency is independent of the speed and radius of the orbit.

OR

(a) Derive, with the help of a diagram, the expression for the magnetic field inside a very long solenoid having n turns per unit length carrying a current I.

(b) How is a toroid different from a solenoid ?

16. सिद्ध कीजिए कि त्रिज्या r की कक्षा में कक्षीय चाल v से किसी नाभिक की परिक्रमा करते हुए किसी इलेक्ट्रॉन का चुम्बकीय आघूर्ण evr/2 होता है । इस प्रकार बोर के कोणीय संवेग के क्वांटमीकरण के अभिगृहीत का उपयोग करते हुए हाइड्रोजन परमाणु के, निम्नतम अवस्था में, चुम्बकीय आघूर्ण के लिए व्यंजक व्युत्पन्न कीजिए । *3*

Prove that the magnetic moment of the electron revolving around a nucleus in an orbit of radius r with orbital speed v is equal to evr/2. Hence using Bohr's postulate of quantization of angular momentum, deduce the expression for the magnetic moment of hydrogen atom in the ground state.

17. σ और -2σ C/m^2 आवेश घनत्व की दो बृहत् आवेशित समतल चादरें एक-दूसरे के बीच पृथकन d के साथ ऊर्ध्वाधर व्यवस्थित की गयी हैं । उस बिन्दु पर विद्युत्-क्षेत्र के लिए व्यंजक व्युत्पन्न कीजिए जो स्थित है (i) पहली चादर के बायीं ओर, (ii) दूसरी चादर के दायीं ओर, तथा (iii) दोनों चादरों के बीच । *3*

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भीतरी त्रिज्या r_1 और बाहरी त्रिज्या r_2 के किसी गोलीय चालक खोल पर आवेश की मात्रा Q है ।

(a) इस खोल के केन्द्र पर कोई आवेश q स्थित है । इस खोल के भीतरी पृष्ठ और बाहरी पृष्ठ पर पृष्ठीय आवेश घनत्व ज्ञात कीजिए ।

(b) क्या किसी विवर (बिना किसी आवेश के) के भीतर विद्युत्-क्षेत्र शून्य होता है; यह इस तथ्य पर निर्भर नहीं करता कि खोल गोलीय है अथवा नहीं ? व्याख्या कीजिए । *3*

Two large charged plane sheets of charge densities σ and -2σ C/m^2 are arranged vertically with a separation of d between them. Deduce expressions for the electric field at points (i) to the left of the first sheet, (ii) to the right of the second sheet, and (iii) between the two sheets.

OR

A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q.

(a) A charge q is placed at the centre of the shell. Find out the surface charge density on the inner and outer surfaces of the shell.

(b) Is the electric field inside a cavity (with no charge) zero; independent of the fact whether the shell is spherical or not ? Explain.

18. निम्न आवृत्ति f_m के किसी सिग्नल को आवृत्ति f_c की वाहक तरंग का उपयोग करके प्रेषित किया जाना है । आयाम मॉडुलित तरंग के लिए व्यंजक व्युत्पन्न कीजिए तथा उत्पन्न निम्न और उच्च पार्श्व बैण्डों के लिए व्यंजक व्युत्पन्न कीजिए । इस प्रकार मॉडुलन सूचकांक के लिए व्यंजक प्राप्त कीजिए । *3*

A signal of low frequency f_m is to be transmitted using a carrier wave of frequency f_c. Derive the expression for the amplitude modulated wave and deduce expressions for the lower and upper sidebands produced. Hence, obtain the expression for modulation index.

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19. प्रकीर्णन कोण के साथ प्रकीर्णित कणों की संख्या का विचरण दर्शाने के लिए गोल्ड की पतली पत्री द्वारा α-कणों के प्रकीर्णन का ग्राफ खींचिए । संक्षेप में वर्णन कीजिए कि किस प्रकार प्रकीर्णन का बृहत् कोण होना परमाणु में नाभिक के अस्तित्व की व्याख्या करता है । संघट्ट प्राचल चित्रण की सहायता से व्याख्या कीजिए कि रदरफोर्ड प्रकीर्णन किस प्रकार नाभिक के साइज़ की उपरि-सीमा निर्धारित करने के एक शक्तिशाली ढंग के रूप में काम आता है । *3*

Draw a plot of α-particle scattering by a thin foil of gold to show the variation of the number of the scattered particles with scattering angle. Describe briefly how the large angle scattering explains the existence of the nucleus inside the atom. Explain with the help of impact parameter picture, how Rutherford scattering serves a powerful way to determine an upper limit on the size of the nucleus.

20. 5 mm पृथकन वाले 200 μF धारिता के किसी समान्तर पट्टिका संधारित्र को 100 V के dc स्रोत द्वारा आवेशित किया गया और स्रोत को संयोजित रखा गया । किसी विद्युत्रोधी हैंडिल द्वारा पट्टिकाओं के बीच की दूरी दुगुनी कर दी गयी और उनके बीच परावैद्युतांक 10 की 5 mm मोटी परावैद्युत पट्टिका रख दी गयी । कारण सहित व्याख्या कीजिए कि निम्नलिखित में क्या परिवर्तन होंगे : (i) संधारित्र की धारिता, (ii) पट्टिकाओं के बीच विद्युत्-क्षेत्र, (iii) संधारित्र का ऊर्जा घनत्व ? *3*

A 200 μF parallel plate capacitor having plate separation of 5 mm is charged by a 100 V dc source. It remains connected to the source. Using an insulated handle, the distance between the plates is doubled and a dielectric slab of thickness 5 mm and dielectric constant 10 is introduced between the plates. Explain with reason, how the (i) capacitance, (ii) electric field between the plates, (iii) energy density of the capacitor will change ?

21. β-क्षय की अवधि में प्रतिन्यूट्रिनो की उपस्थिति का संसूचन कठिन क्यों है ? किसी रेडियोऐक्टिव नाभिक के क्षयांक पद की परिभाषा लिखिए तथा क्षयांक के पदों में इस नाभिक की माध्य आयु के लिए व्यंजक व्युत्पन्न कीजिए । *3*

अथवा

(a) नाभिकीय बल के दो विभेदनकारी लक्षण लिखिए ।

(b) न्यूक्लिऑनों के बीच पृथकन को फलन मानकर न्यूक्लिऑनों के किसी युगल की स्थितिज ऊर्जा के विचरण को दर्शाने के लिए ग्राफ खींचिए । ग्राफ पर उस क्षेत्र को अंकित कीजिए जहाँ पर नाभिकीय बल (i) आकर्षी, तथा (ii) प्रतिकर्षी है । *3*

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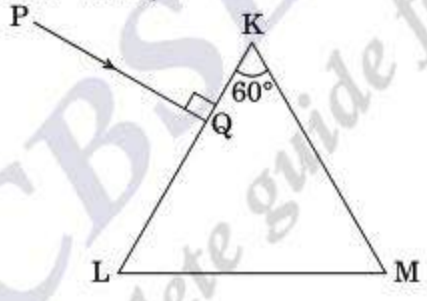
Why is it difficult to detect the presence of an anti-neutrino during β-decay ? Define the term decay constant of a radioactive nucleus and derive the expression for its mean life in terms of the decay constant.

OR

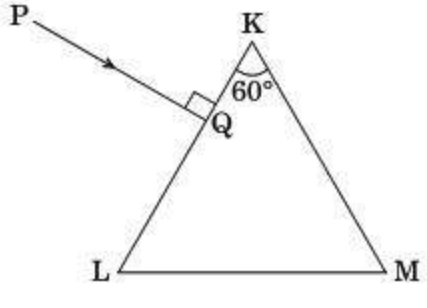
(a) State two distinguishing features of nuclear force.

(b) Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions on the graph where the force is (i) attractive, and (ii) repulsive.

22. $2/\sqrt{3}$ अपवर्तनांक के पारदर्शी माध्यम से बने किसी त्रिभुजाकार प्रिज़्म का अपवर्तन कोण 60° है । आरेख में दर्शाए अनुसार कोई प्रकाश किरण इस प्रिज़्म के फलक KL पर अभिलम्बवत् आपतन करती है । प्रिज़्म में इस किरण का पथ आरेखित कीजिए तथा निर्गत कोण व विचलन कोण परिकलित कीजिए । *3*



A triangular prism of refracting angle 60° is made of a transparent material of refractive index $2/\sqrt{3}$. A ray of light is incident normally on the face KL as shown in the figure. Trace the path of the ray as it passes through the prism and calculate the angle of emergence and angle of deviation.



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23. सिद्ध कीजिए कि किसी उभयनिष्ठ-उत्सर्जक प्रवर्धक में निर्गत और निवेश के बीच 180° कलान्तर होता है ।

किसी ट्रांज़िस्टर में आधार-धारा में 30 μA का परिवर्तन करने पर आधार-उत्सर्जक वोल्टता में 0·02 V और संग्राहक धारा में 4 mA का परिवर्तन उत्पन्न होता है । यदि प्रवर्धक की वोल्टता लब्धि 400 है, तो धारा प्रवर्धन गुणांक और उपयोग किया गया लोड प्रतिरोध परिकलित कीजिए । *3*

Prove that in a common-emitter amplifier, the output and input differ in phase by 180°.

In a transistor, the change of base current by 30 μA produces change of 0·02 V in the base-emitter voltage and a change of 4 mA in the collector current. Calculate the current amplification factor and the load resistance used, if the voltage gain of the amplifier is 400.

24. ताप के फलन के रूप में (i) किसी चालक, और (ii) किसी प्ररूपी अर्धचालक की प्रतिरोधकता के विचरण को दर्शाने के लिए ग्राफ खींचिए ।

संख्या घनत्व और संघट्टों के बीच विश्रांति-काल के पदों में प्रतिरोधकता के लिए व्यंजक का उपयोग करके व्याख्या कीजिए कि ताप में वृद्धि के साथ किस प्रकार चालक के प्रकरण में प्रतिरोधकता में वृद्धि होती है, जबकि अर्धचालक में कमी होती है । *3*

Show, on a plot, variation of resistivity of (i) a conductor, and (ii) a typical semiconductor as a function of temperature.

Using the expression for the resistivity in terms of number density and relaxation time between the collisions, explain how resistivity in the case of a conductor increases while it decreases in a semiconductor, with the rise of temperature.

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खण्ड द

SECTION D

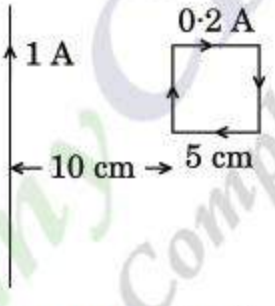
25. (a) किसी एकसमान चुम्बकीय क्षेत्र B में अचर कोणीय चाल ω से घूर्णन करती, फेरों की संख्या N और अनुप्रस्थ-काट क्षेत्रफल A की, किसी कुण्डली में उत्पन्न प्रेरित वि.वा. बल (emf) के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) धातु के 100 अरों, जिनमें प्रत्येक की लम्बाई 0·5 m है, वाला कोई पहिया, पृथ्वी के चुम्बकीय क्षेत्र के क्षैतिज घटक के अभिलम्बवत् तल में, 120 परिक्रमण प्रति मिनट से घूर्णन कर रहा है । यदि उस स्थान पर परिणामी चुम्बकीय क्षेत्र 4×10^{-4} T तथा नति कोण 30° है, तो पहिए की धुरी और नेमि के बीच प्रेरित वि.वा. बल (emf) ज्ञात कीजिए । *5*

अथवा

(a) किसी प्रेरक में धारा I उत्पन्न होने पर उसमें संचित चुम्बकीय ऊर्जा के लिए व्यंजक व्युत्पन्न कीजिए । इस प्रकार चुम्बकीय ऊर्जा घनत्व के लिए व्यंजक प्राप्त कीजिए ।

(b) 5 cm भुजा का कोई वर्ग पाश, जिससे दक्षिणावर्ती दिशा में 0·2 A धारा प्रवाहित हो रही है, आरेख में दर्शाए अनुसार किसी अनन्त लम्बाई के तार, जिससे 1 A धारा प्रवाहित हो रही है, से 10 cm दूरी पर रखा है । पाश पर कार्यरत (i) परिणामी चुम्बकीय बल, तथा (ii) बल आघूर्ण, यदि है, परिकलित कीजिए । *5*



(a) Derive an expression for the induced emf developed when a coil of N turns, and area of cross-section A, is rotated at a constant angular speed ω in a uniform magnetic field B.

(b) A wheel with 100 metallic spokes each 0·5 m long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of the Earth's magnetic field. If the resultant magnetic field at that place is 4×10^{-4} T and the angle of dip at the place is 30°, find the emf induced between the axle and the rim of the wheel.

OR

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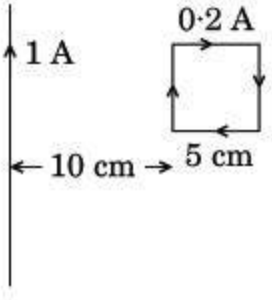
(a) Derive the expression for the magnetic energy stored in an inductor when a current I develops in it. Hence, obtain the expression for the magnetic energy density.

(b) A square loop of sides 5 cm carrying a current of 0·2 A in the clockwise direction is placed at a distance of 10 cm from an infinitely long wire carrying a current of 1 A as shown. Calculate (i) the resultant magnetic force, and (ii) the torque, if any, acting on the loop.



26. आरेख की सहायता से व्याख्या कीजिए कि प्रकीर्णन द्वारा सूर्य के प्रकाश से समतल ध्रुवित प्रकाश किस प्रकार उत्पन्न किया जा सकता है ।

दो पोलेरॉइडों P_1 और P_2 को एक-दूसरे के पास-अक्षों को लम्बवत् रखा गया है । तीव्रता I का अध्रुवित प्रकाश P_1 पर आपतन करता है । P_1 और P_2 के बीच एक तीसरे पोलेरॉइड P_3 को इस प्रकार रखा गया है कि इसका पास-अक्ष P_1 के पास-अक्ष से 45° का कोण बनाता है । P_1, P_2 और P_3 से पारगमित प्रकाश की तीव्रता परिकलित कीजिए । *5*

अथवा

(a) दो सुई छिद्रों को दो सोडियम लैम्पों द्वारा प्रदीप्त करके व्यतिकरण की परिघटना का प्रेक्षण क्यों नहीं किया जा सकता ?

(b) दो कला-संबद्ध स्रोतों से उत्सर्जित दो एकवर्णी तरंगें, जिनके विस्थापन $y_1 = a \cos \omega t$ और $y_2 = a \cos (\omega t + \phi)$ है, व्यतिकरण करके व्यतिकरण पैटर्न उत्पन्न करती हैं । परिणामी तीव्रता के लिए व्यंजक व्युत्पन्न कीजिए तथा संपोषी और विनाशी व्यतिकरण के लिए प्रतिबन्ध प्राप्त कीजिए ।

(c) 590 nm और 596 nm तरंगदैर्घ्य के सोडियम प्रकाश की दो तरंगों का उपयोग बारी-बारी से 2×10^{-6} m द्वारक की किसी एकल झिरी द्वारा विवर्तन का अध्ययन करने के लिए किया गया है । यदि झिरी और पर्दे के बीच की दूरी 1·5 m है, तो दोनों प्रकरणों में पर्दे पर प्राप्त विवर्तन पैटर्नों के द्वितीय उच्चिष्ठों की स्थिति के बीच पृथकन परिकलित कीजिए । *5*

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Explain, with the help of a diagram, how plane polarized light can be produced by scattering of light from the Sun.

Two polaroids P_1 and P_2 are placed with their pass axes perpendicular to each other. Unpolarised light of intensity I is incident on P_1. A third polaroid P_3 is kept between P_1 and P_2 such that its pass axis makes an angle of 45° with that of P_1. Calculate the intensity of light transmitted through P_1, P_2 and P_3.

OR

(a) Why cannot the phenomenon of interference be observed by illuminating two pin holes with two sodium lamps ?

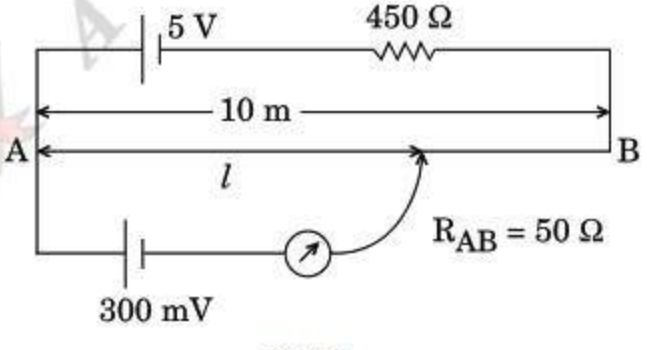
(b) Two monochromatic waves having displacements $y_1 = a \cos \omega t$ and $y_2 = a \cos (\omega t + \phi)$ from two coherent sources interfere to produce an interference pattern. Derive the expression for the resultant intensity and obtain the conditions for constructive and destructive interference.

(c) Two wavelengths of sodium light of 590 nm and 596 nm are used in turn to study the diffraction taking place at a single slit of aperture 2×10^{-6} m. If the distance between the slit and the screen is 1·5 m, calculate the separation between the positions of the second maxima of diffraction pattern obtained in the two cases.

27. (a) परिपथ आरेख की सहायता से किसी सेल के आंतरिक प्रतिरोध को मापने की विधि का संक्षेप में वर्णन कीजिए ।

(b) कारण दीजिए कि किसी सेल के वि.वा. बल (emf) की माप के लिए वोल्टमीटर की तुलना में पोटैन्शियोमीटर के उपयोग को वरीयता क्यों दी जाती है ।

(c) नीचे दिए गए पोटैन्शियोमीटर परिपथ में संतुलन लम्बाई l परिकलित कीजिए । कारण देकर स्पष्ट कीजिए कि यदि सभी अन्य कारकों को अपरिवर्तित रखते हुए 5 V वि.वा. बल (emf) के परिचालक सेल को 2 V के सेल द्वारा प्रतिस्थापित कर दिया जाए, तो यह परिपथ कार्य करेगा अथवा नहीं । *5*



अथवा

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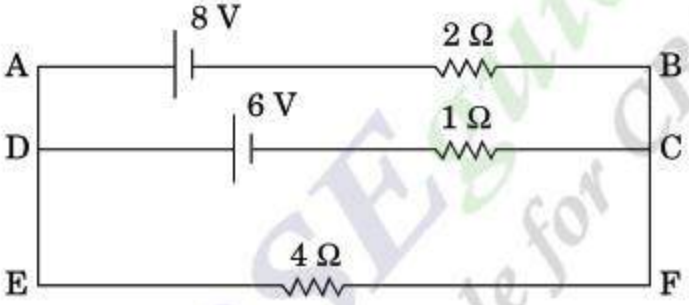
(a) मीटर सेतु द्वारा किसी अज्ञात प्रतिरोध को मापने के कार्यकारी सिद्धांत का उल्लेख कीजिए ।

(b) कारण दीजिए

(i) किसी मीटर सेतु में प्रतिरोधकों के बीच के संयोजनों को मोटे ताँबे की पट्टियों का क्यों बनाया जाता है,

(ii) सामान्यत: संतुलन लम्बाई को सेतु तार के मध्य-बिन्दु के निकट रखने को वरीयता क्यों दी जाती है ।

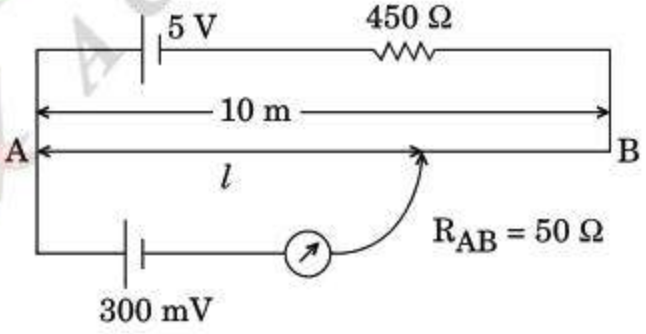
(c) किरखोफ़ के नियम का उपयोग करके दिए गए विद्युत् परिपथ में 4 Ω प्रतिरोधक के सिरों के बीच विभवान्तर परिकलित कीजिए । *5*



(a) Describe briefly, with the help of a circuit diagram, the method of measuring the internal resistance of a cell.

(b) Give reason why a potentiometer is preferred over a voltmeter for the measurement of emf of a cell.

(c) In the potentiometer circuit given below, calculate the balancing length l. Give reason, whether the circuit will work, if the driver cell of emf 5 V is replaced with a cell of 2 V, keeping all other factors constant.



OR

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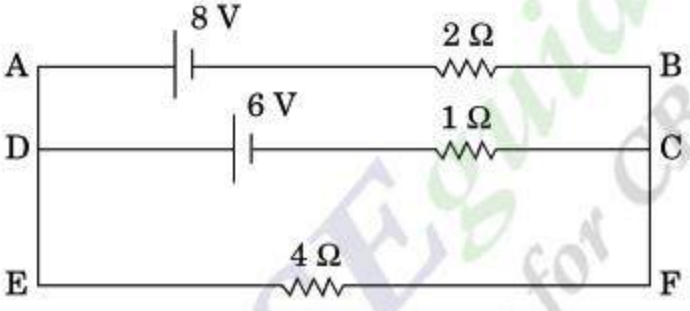
(a) State the working principle of a meter bridge used to measure an unknown resistance.

(b) Give reason

(i) why the connections between the resistors in a metre bridge are made of thick copper strips,

(ii) why is it generally preferred to obtain the balance length near the mid-point of the bridge wire.

(c) Calculate the potential difference across the 4 Ω resistor in the given electrical circuit, using Kirchhoff's rules.



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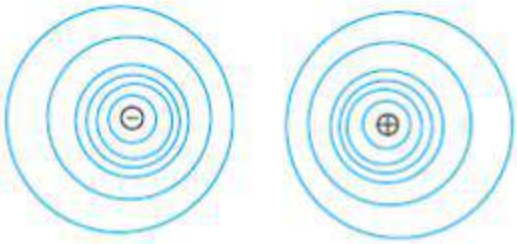
Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
1	• For drawing equipotential surfaces for an electric dipole. 1  (Even if a student mentions or draws equatorial plane, award 1 mark.)	1	1
2	• For writing the expression for radius 1/2 • To find the change in the radius of the circular orbit 1/2 $r = \frac{1}{B}\sqrt{\frac{2mV}{q}}$ $r' = \sqrt{2}r$ *Alternatively* $r \alpha \sqrt{V}$ $\frac{r'}{r} = \sqrt{2}$ *Even if student writes* $Bqv = \frac{mv^2}{r}$ *award one mark*	½ ½ ½ ½	1 1
3	• For writing relationship between susceptibility and temperature 1/2 • Calculating the temperature 1/2 $\chi_m \propto \frac{1}{T}$ $T_2 = \frac{\chi_{m1}}{\chi_{m2}} \times T_1$ $T_2 = \frac{1.2 \times 10^5}{1.44 \times 10^5} \times 300 = 250K$ **OR** • For identification of magnetic material 1	½ ½	1

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Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
	It is diamagnetic material	1	1
4	• For identification of semiconductor diode 1 It is photodiode	1	1
	SECTION-B		
5	• To identify the part of the electromagnetic spectrum 1/2 • For writing its frequency range 1/2 Microwaves Frequency range is 10^{10} to 10^{12} Hz	½ ½	1
	OR		
	• Production of electromagnetic wave 1 Accelerated charge produces an oscillating electric field which produces an oscillating magnetic field, which is a source of oscillating electric field, and so on. Thus electromagnetic waves are produced.	1	1
6	• For writing expression for total current 1 • For showing that displacement current is the same as the current charging the capacitor 1 $i = i_c + i_d$ Where i_c is conduction current and i_d is displacement current Outside the capacitor $i_d = 0$ so $i = i_c$ Inside the capacitor $i_c = 0$ so $i = i_d$	1 ½ ½	2
7	• For writing expression for energy of photon ½ • For writing expression for kinetic energy of proton 1 • For proving the relationship between the two ½ Energy of photon $E_p = \frac{hc}{\lambda}$	½	

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
	For proton $\lambda = \frac{h}{mv}$ $mv = \frac{h}{\lambda}$ Kinetic energy of proton $E_k = \frac{1}{2}mv^2$ $E_k = \frac{1}{2}\frac{h^2}{m\lambda^2}$ $E_p = \left(\frac{2m\lambda c}{h}\right)E_k$	½ ½ ½	2
8	• For writing Einstein's photoelectric equation 1/2 • For writing $E_n = -\frac{13.6}{n^2}$ 1/2 • For finding the value of n 1 From photoelectric equation $h\nu = \phi_0 + eV_s$ = 2+ 0.55 = 2.55 eV Given $E_n = -\frac{13.6}{n^2}$ The energy difference $\Delta E = -3.4 - (-2.55)\,eV = -0.85\,eV$ $\therefore \frac{-13.6}{n^2} = -0.85$ $\because n = 4$ **OR** • Calculation of energy in excited state ½ • Formula ½ • Finding out the maximum number of lines 1 Energy in ground state, $E_1 = -13.6eV$ Energy supplied=$12.5eV$ Energy in excited state, $-13.6 + 12.5 = -1.1eV$ But, $E_n = \frac{-13.6}{n^2} = -1.1$ $n = 3$ Maximum number of lines=3	½ ½ ½ ½ ½	2 2

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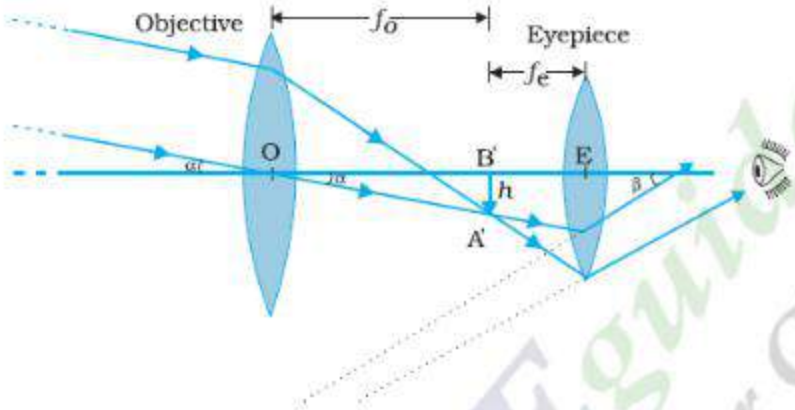
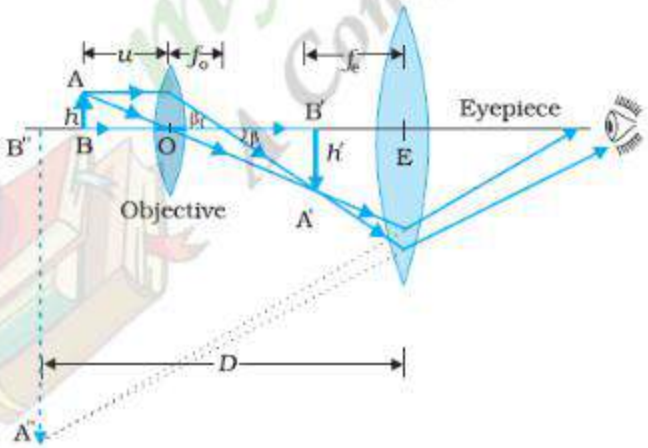
Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
9	• To draw the ray diagram of astronomical telescope 1 ½ • Expression for magnification 1/2		
	Ray diagram  	1½	2
	Magnification $= \frac{f_o}{f_e}$ Or $m = \frac{\beta}{\alpha}$	½	
	OR • To draw the ray diagram of compound microscope 1½ • Expression for resolving power 1/2		
	Ray diagram  	1½	2
	Resolving power $= \frac{2n\sin\beta}{1.22\lambda}$	½	

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Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
10	• Relation ½ • Modified relation in case of line of sight 1 • Range of frequency ½ $d = \sqrt{2hR}$ In case of line of sight of communication $d = \sqrt{2h_R R} + \sqrt{2h_T R}$ Frequency range is above $40Mhz$	½ 1 ½	2
11	• Conditions 1 • Distinction between primary and secondary rainbow 1 **Conditions** (i) Sun must be on the back side of the observer (ii) Presence of water droplets Distinction between the primary and secondary rainbow **Primary rainbow** / **Secondary rainbow** 1. Internal reflection takes place once. / 1. Internal reflection takes place twice. 2. Intensity is higher / 2. Intensity is low **Note:** Even if student attempt by writing just the Q. No. or student just writes TIR (total internal reflection) etc. award full **two** marks.	½ ½ ½ ½	2
12	• Explaining the cause of bluish color of sky 1 • Appearance of sun red at the time of sun rise and sun set 1 (a) Scattering is inversely proportional to the fourth power of wavelength. ***Or*** Shorter wavelength scatters more hence sky appear blue. (b) Red color is least scattered. So by the time light reaches the surface of earth all the colors except red get scattered away.	1 1	2
13	• Calculation of impedance 2 • Calculation of inductance 1 $Z = \sqrt{R^2 + X_c^2}$ $R = \frac{V_R}{I_R} = 30\Omega$	½ ½	

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$X_c = \frac{V_c}{I_c} = \frac{120}{30} = 40\Omega$	½	
	$Z = \sqrt{(30)^2 + (40)^2} = 50\Omega$	½	
	$X_c = X_L$ As power factor =1 $100\pi L = 40$	½	
	$L = \frac{2}{5\pi}\ henry$	½	3
	OR		
	• Determining the source frequency 1 • Calculating impedance 1/2 • For showing potential drop across LC 1 ½		
	(a) $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{5\times 80\times 10^{-6}}} = \frac{1}{\sqrt{400\times 10^{-6}}}$ $\omega = \frac{1000}{20} = 50Hz$	1	
	(b) $Z = R = 40\Omega$	½	
	$I_m^{max} = \frac{230\sqrt{2}}{R} = \frac{230\sqrt{2}}{40} = 8.1A$	½	
	$V_c = I_m^{max} X_c = \frac{230\sqrt{2}}{40} \times \frac{1}{\omega C} = 2033\ volt$		
	$V_L = I_m^{max} X_L = \frac{230\sqrt{2}}{40} \times 2\pi\nu L = 2033\ volt$	½	
	(c) $V_c - V_L = 0$	½	3
14	• Reason to explain why n-p region of zener diode is heavily doped 1 ½ • Calculation of current through zener diode 1 ½		
	n and p regions of zener diode are heavily doped so that depletion region formed is very thin and electric field at the junction is extremely high even for a small reverse bias voltage. Current in the circuit is:	1 ½	
	$I = \frac{V}{R} = \frac{5}{250} = \frac{1}{50} = .02A$ Current through resistor of $1k\Omega$ is:	½	

Marking Scheme

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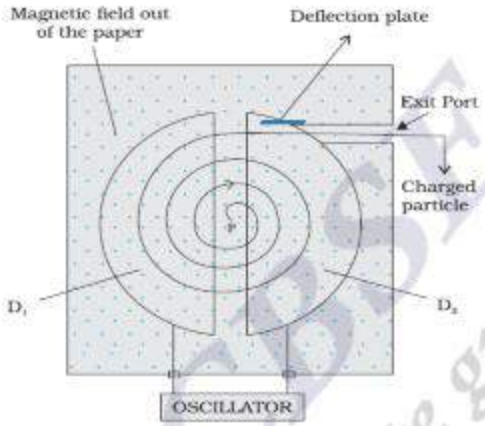
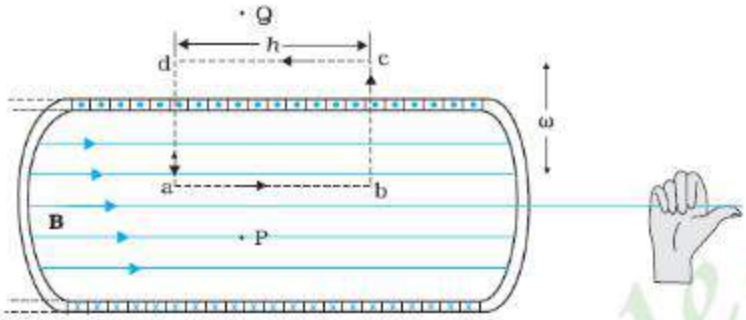
Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$I = \frac{15}{1000} = 0.015A$	½	
	As zener diode and $1k\Omega$ resistor are in parallel, current through the zener diode is: $I = 0.02 - 0.015 = .005A$	½	3
15	• Diagram of cyclotron 1 • Explaining the working principle 1 • Showing frequency is independent of radius and speed 1 Diagram:  	1	
	Working principle: The cyclotron uses crossed electric and magnetic fields which increases the kinetic energy of a charged particle without changing its frequency of revolution.	1	
	$F_c = F_m$ $\frac{mv^2}{r} = qvB$	½	
	$\omega = \frac{qB}{m}$ $\nu = \frac{qB}{2\pi m}$	½	3
	OR		
	• Diagram of straight solenoid ½ • Derivation of magnetic field 1+1/2 • Difference between toroid and solenoid (any one) 1		
	Diagram		

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
		½	
	Derivation: Let n be the number of turns per unit length. The total number of turns is nh. The enclosed current is $I_e = I(nh)$	½	
	From Ampere's circuital law $BL = \mu_0 I_e$ $Bh = \mu_0 I(nh)$ $B = \mu_o nI$	1	
	Difference between toroid and solenoid (any one) (a) Solenoid behaves like a bar magnet whereas toroid does not. Or If student writes solenoid is straight and the toroid is circular give half mark. Or there is fringe effect in case of straight solenoid but not in toroid (allot one mark.)	1	3
16	Proving magnetic moment as $\frac{e\text{vr}}{2}$ 2 Deducing expression of the magnetic moment of hydrogen atom 1		
	The magnetic moment is $m = IA$	½	
	But current is $I = \frac{e}{T} = \frac{e\text{v}}{2\pi r}$	½	
	Where $T = \frac{2\pi r}{\text{v}}$ *and the area,* $A = \pi r^2$	½	3
	$m = \frac{e\text{v}}{2\pi r}\pi r^2 = \frac{e\text{vr}}{2}$	½	
	But from Bohr's second postulate $m_e \text{vr} = \frac{nh}{2\pi} = \frac{h}{2\pi}$ for n=1	½	
	$\text{v}r = \frac{nh}{2\pi m_e}$ Hence the magnetic moment is		

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Marking Scheme

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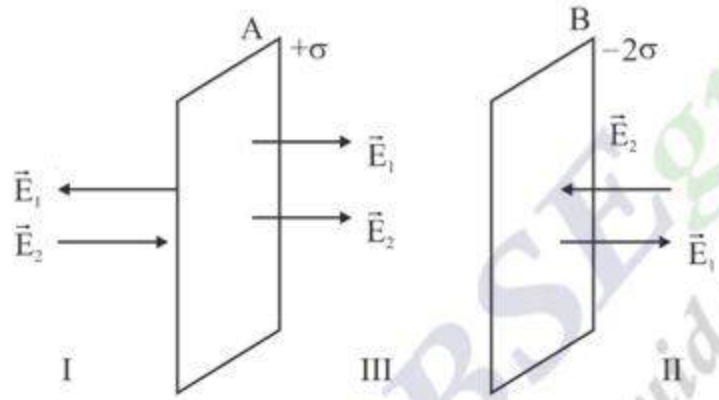
Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$m = \frac{e}{2}\frac{h}{2\pi m_e} = \frac{eh}{4\pi m_e}$ (Here n=1)	½	
17	Diagram 1+1/2 Deducing electric field expression (i) To the left of first sheet (ii) To the right of second sheet (iii) Between the two sheets 1/2+1/2+1/2 Diagram  Electric field in the region left of first sheet $E_I = E_1 + E_2$ $E_I = \frac{\sigma}{\varepsilon_0} - \frac{\sigma}{2\varepsilon_0}$ $E_I = +\frac{\sigma}{2\varepsilon_0}$ It is towards right Electric field in the region to the right of second sheet $E_{II} = \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{\varepsilon_0}$ $E_{II} = -\frac{\sigma}{2\varepsilon_0}$ It is towards left Electric field between the two sheets	1½ ½ ½	3

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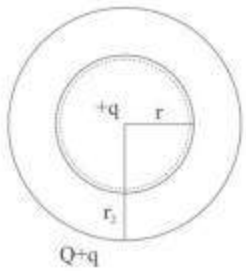
Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$E_{III} = E_1 + E_2$ $E_{III} = \frac{\sigma}{\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}$ $E_{III} = \frac{3\sigma}{2\varepsilon_0}$ Electric field is towards the right	½	
	OR		
	Diagram ½ Finding the surface charge density in the inner and outer surface of the shell 1+1/2 Electric field in the cavity 1		
	(a) Diagram  	½	
	The surface charge density on inner surface of the shell is $\sigma_1 = -\frac{q}{4\pi r_1^2}$	1	
	The surface charge density on outer shell is $\sigma_2 = \frac{Q+q}{4\pi r_2^2}$	½	
	(b) Consider a Gaussian surface inside the shell, net flux is zero since $q_{net} = 0$. According to Gauss's law it is independent of shape and size of shell.	1	3
18	• Derive expression for amplitude modulated wave. 2 • Deducing expression for lower and upper side bands. ½ • Obtaining expression for modulation index. ½		
	Let a carrier wave be given by $c(t) = A_c \sin \omega_c t$ where $\omega_c = 2\pi f_c$ And signal wave be $m(t) = A_m \sin \omega_m t$ where $\omega_m = 2\pi f_m$ The modulated signal is $c_m(t) = (A_c + A_m \sin \omega_m t)\sin \omega_c t$	½	

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Marking Scheme

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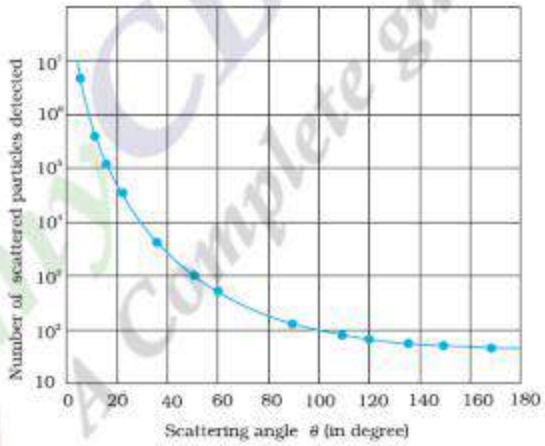
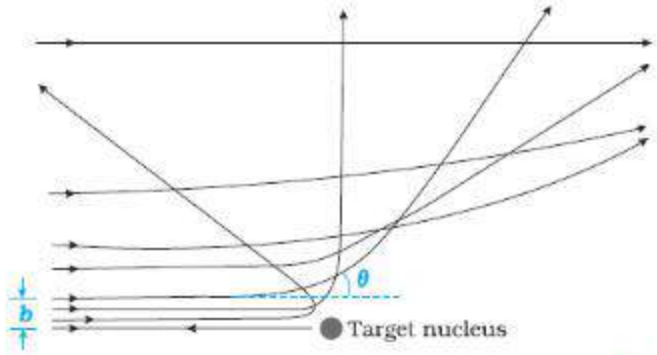
Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$c_m(t) = A_c(1+\frac{A_m}{A_c}\sin\omega_m t)\sin\omega_c t$	½	
	$c_m(t) = A_c\sin\omega_c t + \mu\frac{A_c}{2}\cos(\omega_c-\omega_m)t - \mu\frac{A_c}{2}\cos(\omega_c+\omega_m)t$	½	
	The modulation index $\mu = \frac{A_m}{A_c}$	½	
	Lower frequency band $\omega_c - \omega_m$	½	
	Upper frequency band $\omega_c + \omega_m$	½	3
19	• Draw a plot of α -particle scattering to show variation of scattering particle. 1 • Describe briefly how large scattering explains existence of nucleus. 1 • Explain with the help of impact parameter picture how Rutherford scattering serves powerful way to determine upper limit of nucleus. 1		
		1	
	The data shows that large number of α -particle do not suffer large scattering but small number suffer greater scattering it is concluded that	½	
	(i) most of the atom is empty space (ii) massive positively charged nucleus occupies small region.	½	

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
		½	
	From the picture it is clear that for small impact parameter suffers large scattering thus it shows the upper limit to the size of nucleus.	½	3
20	(i) Change in capacitance 1 (ii) Change in electric field 1 (iii) Change in electric density 1 Dielectric slab of thickness 5mm is equivalent to an air capacitor of thickness $=\frac{5}{10}mm$. Effective separation between the plates with air in between is $=(5+0.50)mm=5.5mm$	½	
	(i) Effective new capacitance $=200\mu F\times\frac{5mm}{5.5mm}=\frac{2000}{11}\mu F$ $\approx 182\mu F$	1	
	(ii) Effective new electric field $=\frac{100\,V}{5.5\times10^{-3}m}=\frac{20000}{11}$ $\approx 18182\,V/m$	½	
	(iii) $\frac{New\ energy\ stored}{Original\ energy\ stored}=\frac{\frac{1}{2}C'V^2}{\frac{1}{2}CV^2}=\frac{C'}{C}=\frac{10}{11}$ New Energy density will be $\left(\frac{10}{11}\right)^2$ of the original energy density $=\frac{100}{121}$ of the original energy density. Note: If the student writes $C=\frac{A\varepsilon_0}{d}$ $C_m=\frac{KA\varepsilon_0}{d}$	1	

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Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$E' = \frac{V}{d}$ $U = \frac{1}{2}\varepsilon_0 E^2$ Award full marks		
21	• Reason for difficulty in detecting presence of anti-neutrino during $\beta - decay$ ½ • Define decay constant of radioactive nucleus ½ • Derive expression for mean life in terms of decay constant 2		
	• Penetrating power is high • Do not interact with matter (weak interaction) any one	½	
	• Decay constant is the reciprocal of the time duration in which undecayed radioactive nuclei reduce to 1/e times the nuclei present initially.	1	
	$\tau = \frac{\text{total life time of all nuclei}}{\text{total number of nuclei}}$	½	
	$\tau = \frac{\int_0^\infty t dN}{N_0}$	½	
	$\tau = \frac{\int_0^\infty t(N_0 \lambda \varepsilon^{-\lambda t} dt)}{N_0} = \lambda \int t e^{-\lambda \tau} dt$		
	$\tau = \frac{1}{\lambda}$	½	3
	OR (a) Stating distinguishing feature of nuclear force. 1 (b) Drawing a plot showing variation of potential energy. 1 (c) Marking the regions. 1/2+1/2		
	(1) Short rang force (2) Strongest force (3) Attractive in nature (4) Does not depend on charge (any two)	1	

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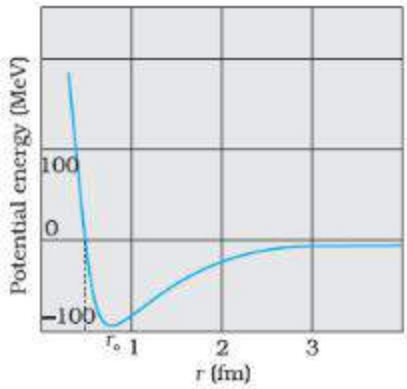
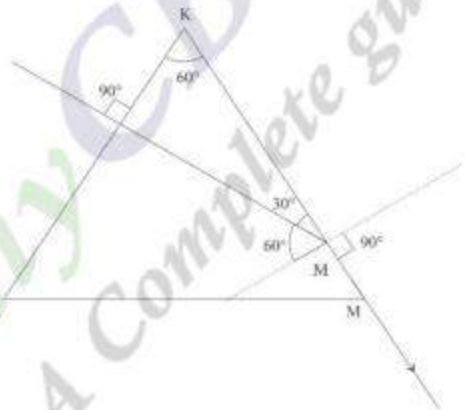
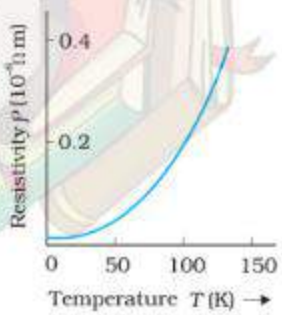
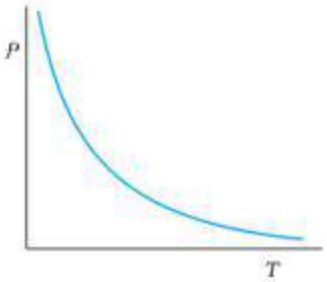
Q. No.	Value Points/Expected Answers	Marks	Total Marks
	(b) Figure 	1	
	$r < r_0$ repulsive force	½	
	$r > r_0$ attractive force	½	3
22	• Tracing path of ray passing through prism 1 • Calculating angle of emergence and angle of deviation 1 ½+1/2		
	Ray diagram: 	1	
	• A=60° • $\frac{2}{\sqrt{3}}\sin 60^o = \sin r$	1½	3
	• $\sin r = \frac{2\sqrt{3}}{2\sqrt{3}} = 1$ • $r = 90^o$ Angle of deviation is equal to 30°	½	
23	• Proving the phase difference 1 • Calculation of Amplification factor 1 • Calculation of load resistance 1		

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
	Input signal, $V_i = \Delta I_B r_i$ Output signal, $V_o = -\Delta I_c R_L$ Voltage amplification, $A_V = \frac{V_o}{V_i}$ • $A_V = -\frac{\Delta I_B}{\Delta I_C} \times \frac{r_i}{R_L}$ • $A_V = -\beta \times$ resistance gain Here negative sign indicates that output is 180° out of phase w.r.t. input signal. • $\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{4\times10^{-3}}{30\times10^{-6}} = \frac{400}{3}$ $r_i = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{0.02}{30\times10^{-6}} = \frac{2\times10^{-2}}{3\times10^{-5}}$ • $r_i = \frac{2}{3}\times10^3\,\Omega$ $A_V = \beta\frac{R_L}{r_i}$ $R_L = \frac{A_V \times r_i}{\beta} = \frac{400\times2\times10^3\times3}{400\times3} = 2\times10^3\,\Omega$	½ ½ 1 ½ ½	3
24	• Showing the plot of variation of resistivity ½ + ½ • Expression for resistivity 1 • Explaining variation of resistivity for conductor and semiconductor ½ + ½   	½ ½	

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
	• $\rho = \frac{m}{ne^2\tau}$ • In case of conductors with increase in temperature, relaxation time decreases, so resistivity increases. • In case of semiconductors with increase in temperature number density (n) of free electrons increases, hence resistivity increases.	1 ½ ½	3
25	• Deriving expression for e.m.f. 3 • Finding induced e.m.f. between the axel and rim of wheel 2 Flux linked with the coil at any instant of time is: $\phi = NBA\cos\omega t$ $\frac{d\phi}{dt} = NBA\omega(-\sin\omega t)$ S $\varepsilon = -\frac{d\phi}{dt}$ $\varepsilon = NBA\omega\sin\omega t$ $\varepsilon = \varepsilon_0 \sin\omega t$ (Here $\varepsilon_0 = NBA\omega$) (b) $l = 0.5m,\ \nu = 120rpm = 2rps$ $\omega = 2\pi\nu = 4\pi\ rad/s,\ B = 4\times10^{-4}T,\ \delta = 30^0$ $B_H = 4\times10^{-4}\times\frac{\sqrt{3}}{2}$ $B_H = 2\sqrt{3}\times10^{-4}T$ $\varepsilon = \frac{1}{2}B\omega l^2$ $\varepsilon = \frac{1}{2}\times2\sqrt{3}\times10^{-4}\times4\pi\times(0.5)^2$ $\varepsilon = 5.4\times10^{-4}\ volt$ ***OR*** • Deriving expression for magnetic energy stored in inductor and expression for energy density 1½+ ½ • Calculating the resultant magnetic force and torque 2½+ ½ (a) When external source supplies current to the inductor, e.m.f. is induced in it due to self induction. So the external supply has to do work to establish current. The amount of work done is: $dw = \lvert\varepsilon\rvert Idt \quad \because \varepsilon = L\frac{dI}{dt}$ $dw = LIdt$	½ 1 ½ ½ ½ 1 1 ½	5

Marking Scheme

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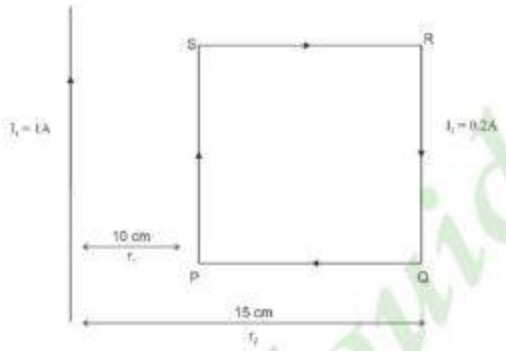
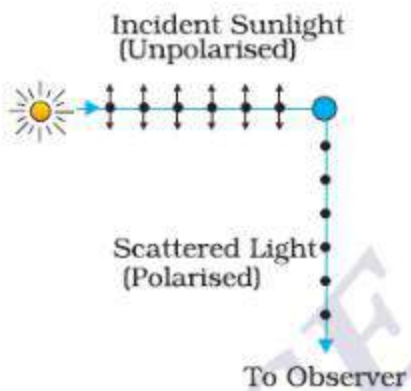
Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$W = \frac{1}{2}LI^2$	1	
	Energy density $= \frac{Energy}{Volume}$		
	$u = (1/2LI^2)/volume$	½	
	(b) 		3
	Force of attraction experienced by the length SP of the loop per unit length		
	$F_1 = \frac{2\mu_0 I_1 I_2}{4\pi r_1}$	½	
	$f_1 = \frac{2\times10^{-7}\times1\times0.2}{10\times10^{-2}} = 4\times10^{-7}\,Nm^{-1}$	½	
	Force is attractive		
	$f_2 = \frac{2\mu_0 I_1 I_2}{4\pi r_2}$	½	
	$f_2 = \frac{2\times10^{-7}\times1\times0.2}{15\times10^{-2}} = 2.6\times10^{-7}\,Nm^{-1}$	½	
	Force is repulsive		
	So the net force experienced by the loop is (per unit length)		
	$f = (f_1 - f_2)$		
	Total force experienced by the loop is:		
	$F = (f_1 - f_2)l = (1.4\times10^{-7})\times5\times10^{-2}$	½	
	$F = 7\times10^{-7}\,N$		
	Net force is attractive in nature	½	5
	As the lines of action of forces coincide torque is zero.		

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
26	• Diagram production of polarized light by scattering of sun light 1 • Explanation 1 • Calculation of intensity of light transmitted through P_1, P_2 *and* P_3 ½ +1+1½		
	Diagram:		
		1	
	Explanation: Charges accelerating parallel to the double arrows do not radiate energy towards the observer. The radiation scattered by the molecules therefore is polarised perpendicular to the plane of the figure. ALTERNATIVELY : If the student writes " scattered light when viewed in a perpendicular direction is found to be polarised " (award one mark)		
	Intensity of light transmitted by 1st Polaroid is, $I_1 = \frac{I}{2}$	1	
	Intensity of light transmitted by 2nd Polaroid is, $I_2 = I_1 \cos^2 45^0 = \frac{I}{2}\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I}{4}$	½	
	Intensity of light transmitted by 3rd Polaroid is, $I_3 = I_2 \cos^2 45^0 = \frac{I}{2}\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I}{8}$	1	5
	OR	1½	
	• Reason ½ • Deriving the expression for resultant intensity and condition for constructive and destructive interference $1\frac{1}{2} + ½ + ½$ • Calculating the separation 2		
	(a) Because two independent sources cannot be coherent OR they are not coherent		
	(b) $y_1 = a\cos\omega t$ $y_2 = a\cos(\omega t + \phi)$	½	

Marking Scheme

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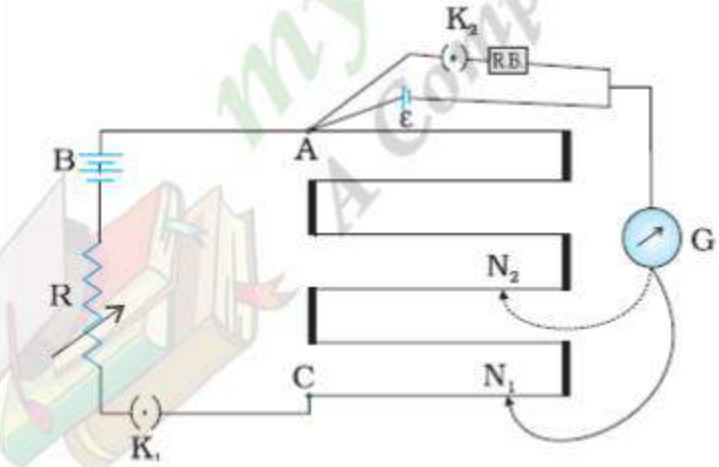
Q. No.	Value Points/Expected Answers	Marks	Total Marks
	So resultant displacement is give by $y = y_1 + y_2$ $y = a\cos\omega t + a\cos(\omega t + \phi)$ $y = 2a\cos(\phi/2)\cos(\omega t + \phi/2)$ The amplitude of the resultant displacement is $2a\cos(\phi/2)$ and therefore intensity at that point will be $I = 4I_0\cos^2(\phi/2)$ For constructive interference: $\phi = 0, \pm 2\pi, \pm 4\pi, ...$ For destructive interference: $\phi = \pm\pi, \pm 3\pi, \pm 5\pi, ...$ (c) Position of second maxima $y_2 = \frac{5}{2}\frac{\lambda D}{a}$ Separation between the positions of the second maxima with λ_1 and λ_2 is: $\Delta y = \frac{5D(\lambda_2 - \lambda_1)}{2a} = \frac{5\times 1.5\times(596-590)\times 10^{-9}}{2\times 2\times 10^{-6}} = 11.25\times 10^{-3} m$	1 ½ ½ ½ 1 1	5
27	• Circuit diagram and describing the method to measure internal resistance of cell by potentiometer 1+1 • Reason 1 • Calculating balancing length and reason (circuit works or not) 1½ +1 (a) Circuit diagram:  Brief description: Plug in the key k_1 and keep k_2 unplugged and the find the balancing length l_1 such that: $E = kl_1$ (1) With the key k_2 also plugged in find out balancing length l_2 again such that:	1 ½	

Marking Scheme

55/2/1

Q. No.	Value Points/Expected Answers	Marks	Total Marks
	$V = kl_2 \quad (2)$ As $r = \left(\frac{E}{V} - 1\right)R$ $r = \left(\frac{l_1}{l_2} - 1\right)R$	½	
	(b) The potentiometer is preferred over the voltmeter for measurement of e.m.f. of a cell because potentiometer draws no current from the voltage source being measured.	½	
	(c) $V = 5V,\ R_{AB} = 50\Omega,\ R = 450\Omega$ $I = \frac{5}{450+50} = \frac{1}{100} = 0.01A$ $V_{AB} = 0.01 \times 50 = 0.5V$	s ½	
	$k = \frac{0.5}{10} = 0.05Vm^{-1}$	½	
	$l = \frac{V}{k} = \frac{300 \times 10^{-3}}{0.05} = 6m$	½	
	With 2V driver cell current in the circuit is $I = \frac{2}{450+50} = 0.004A$.	½	
	P.d. across AB is =0.004×50=200mV. Hence the circuit will not work.	½	
	OR • State the working principle of meter bridge 1 • Reasons 1/2 +1/2 • Calculation of potential difference using Kirchhoff's rules 3		
	(a) Meter bridge is based on the principle of balanced Wheatstone bridge.	1	
	(b) (i) Thick copper strips are used to minimize resistance of connections which are not accounted for in the bridge formula	½	
	(ii) Balance point is preferred near midpoint of bridge wire to minimize percentage error in resistance (R).	½	
	(c)		

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Marking Scheme

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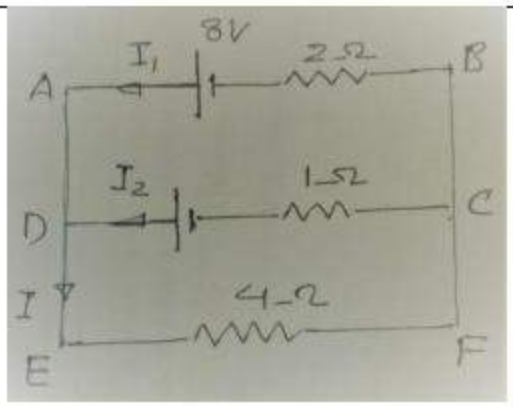
Q. No.	Value Points/Expected Answers	Marks	Total Marks
		1	
	$I = I_1 + I_2 \quad (1)$ *In loop ABCDA* $-8 + 2I_1 - 1\times I_2 + 6 = 0 \quad (2)$ *In loop DEFCD* $-4I - 1\times I_2 + 6 = 0$ $4I + I_2 = 6$ $4(I_1 + I_2) + I_2 = 6$ $4I_1 + 5I_2 = 6 \quad (3)$ *From equations* (1) *and* (2) *we get* $I_1 = \frac{8}{7}A,\ I_2 = \frac{2}{7}A,\ I = \frac{10}{7}$ Potential difference across resistor 4Ω is: $V = \frac{10}{7}\times 4 = \frac{40}{7}\,volt$	1 ½ ½	5

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SET-1

Series BVM/3

कोड नं.
Code No. **55/3/1**

रोल नं.
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 **19** 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 **27** 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 जाएगा । 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 **19** 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 **27** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minute 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 घण्टे | *अधिकतम अंक : 70*

Time allowed : 3 hours | *Maximum Marks : 70*

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सामान्य निर्देश :

(i) **सभी** प्रश्न अनिवार्य हैं । इस प्रश्न-पत्र में कुल **27** प्रश्न हैं ।

(ii) इस प्रश्न-पत्र के **चार** भाग हैं : खण्ड अ, खण्ड ब, खण्ड स और खण्ड द ।

(iii) खण्ड अ में **पाँच** प्रश्न हैं, प्रत्येक का **एक** अंक है । खण्ड ब में **सात** प्रश्न हैं, प्रत्येक के **दो** अंक हैं । खण्ड स में **बारह** प्रश्न हैं, प्रत्येक के **तीन** अंक हैं । खण्ड द में **तीन** प्रश्न हैं, प्रत्येक के **पाँच** अंक हैं ।

(iv) प्रश्न-पत्र में समग्र पर कोई विकल्प नहीं है । तथापि, **एक** अंक वाले **दो** प्रश्नों में, **दो** अंकों वाले **दो** प्रश्नों में, **तीन** अंकों वाले **चार** प्रश्नों में और **पाँच** अंकों वाले **तीनों** प्रश्नों में आन्तरिक चयन प्रदान किया गया है । ऐसे प्रश्नों में आपको दिए गए चयन में से केवल **एक** प्रश्न ही करना है ।

(v) जहाँ आवश्यक हो, आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :

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

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

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

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

इलेक्ट्रॉन का द्रव्यमान $(m_e) = 9{\cdot}1 \times 10^{-31}$ kg

न्यूट्रॉन का द्रव्यमान $= 1{\cdot}675 \times 10^{-27}$ kg

प्रोटॉन का द्रव्यमान $= 1{\cdot}673 \times 10^{-27}$ kg

आवोगाद्रो संख्या $= 6{\cdot}023 \times 10^{23}$ प्रति ग्राम मोल

बोल्ट्ज़मान नियतांक $= 1{\cdot}38 \times 10^{-23}$ JK^{-1}

General Instructions :

(i) ***All*** *questions are compulsory. There are* ***27*** *questions in all.*

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

(iii) *Section A contains* ***five*** *questions of* ***one*** *mark each, Section B contains* ***seven*** *questions of* ***two*** *marks each, Section C contains* ***twelve*** *questions of* ***three*** *marks each, Section D contains* ***three*** *questions of* ***five*** *marks each.*

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(iv) *There is no overall choice. However, an internal choice(s) has been provided in* ***two*** *questions of* ***one*** *mark,* ***two*** *questions of* ***two*** *marks,* ***four*** *questions of* ***three*** *marks and* ***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 :*

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

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

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

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (m_e) = $9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

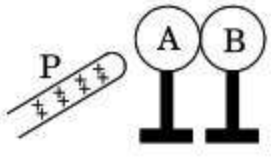
Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

खण्ड अ

SECTION A

1. विद्युत्-रोधी आधारों पर रखे दो धात्विक गोले A और B एक-दूसरे के सम्पर्क में हैं । आरेख में दर्शाए अनुसार कोई धनावेशित छड़ P गोले A के निकट लाई गई है । इन दोनों गोलों को एक-दूसरे से पृथक् करके छड़ P को हटा दिया गया है । गोले A और B पर आवेशों की प्रकृति क्या होगी ? *1*



अथवा

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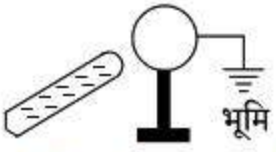
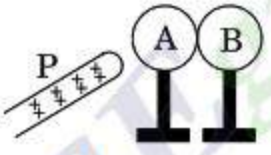
कोई धात्विक गोला किसी विद्युत्-रोधी आधार पर रखा है । किसी ऋणावेशित छड़ को इस गोले के निकट लाकर, दर्शाए अनुसार गोले को भूसम्पर्कित कर दिया गया है । भूसम्पर्कण को हटाने और ऋणावेशित छड़ को दूर ले जाने पर, गोले पर आवेश की प्रकृति क्या होगी ? अपने उत्तर के लिए कारण दीजिए । *1*

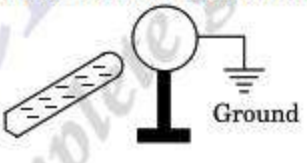


Two metallic spheres A and B kept on insulating stands are in contact with each other. A positively charged rod P is brought near the sphere A as shown in the figure. The two spheres are separated from each other, and the rod P is removed. What will be the nature of charges on spheres A and B ?

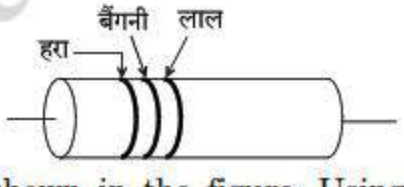


OR

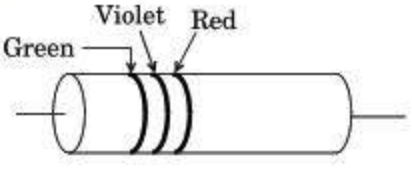
A metal sphere is kept on an insulating stand. A negatively charged rod is brought near it, then the sphere is earthed as shown. On removing the earthing, and taking the negatively charged rod away, what will be the nature of charge on the sphere ? Give reason for your answer.



2. आरेख में किसी कार्बन प्रतिरोधक को दर्शाया गया है । वर्ण कोड का उपयोग करके इस प्रतिरोध का मान लिखिए । *1*



A carbon resistor is shown in the figure. Using colour code, write the value of the resistance.



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3. उस स्थिति का उल्लेख कीजिए जिसमें किसी खगोलीय दूरबीन में वृहत् आवर्धन प्राप्त किया जा सकता है । *1*

अथवा

यदि आपतित बैंगनी प्रकाश को लाल प्रकाश से प्रतिस्थापित कर दिया जाए, तो किसी काँच के प्रिज़्म में न्यूनतम विचलन कोण का विचरण किस प्रकार होगा ? *1*

State the condition under which a large magnification can be achieved in an astronomical telescope.

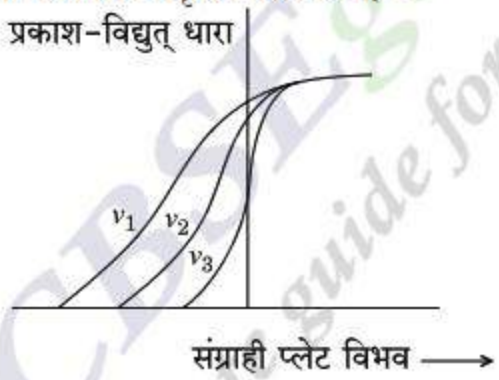
OR

How does the angle of minimum deviation of a glass prism vary if the incident violet light is replaced by red light ?

4. आरेख में दर्शाए गए ग्राफ के आधार पर नीचे दिए गए प्रश्नों के उत्तर दीजिए : *1*

(a) इन तीन वक्रों में किस भौतिक प्राचल को नियत रखा गया है ?

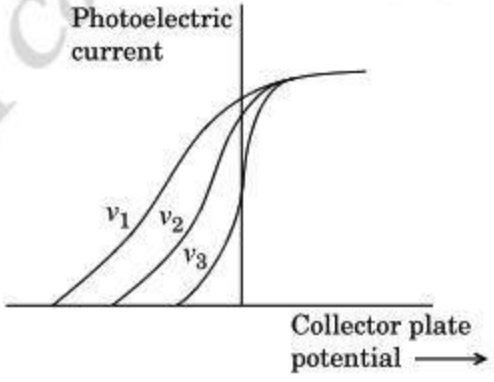
(b) ν_1, ν_2 व ν_3 में से कौन-सी आवृत्ति अधिकतम है ?



On the basis of the graphs shown in the figure, answer the following questions :

(a) Which physical parameter is kept constant for the three curves ?

(b) Which is the highest frequency among ν_1, ν_2 and ν_3 ?



5. संचार प्रणाली में आयाम मॉडुलन की परिभाषा लिखिए । *1*

Define amplitude modulation in communication system.

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खण्ड ब

SECTION B

6. भुजा 'l' के किसी सम षड्भुज के पाँच शीर्षों पर पाँच बिन्दु आवेश, जिनमें प्रत्येक $+q$ है, स्थित हैं । इस षड्भुज के केन्द्र पर स्थित आवेश $-q$ पर परिणामी बल का परिमाण ज्ञात कीजिए । 2

अथवा

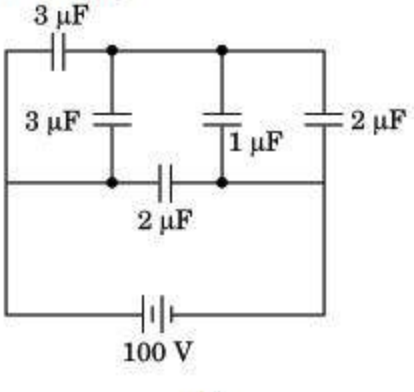
m द्रव्यमान के किसी लघु गोले से बने सरल लोलक को लम्बाई l के धागे से निलंबित किया गया है । इस गोले पर कोई धनावेश q है । यह लोलक ऊर्ध्वाधर नीचे की ओर दिष्ट तीव्रता E के एकसमान विद्युत्-क्षेत्र में स्थित है । गुरुत्वीय बल के प्रभाव की उपेक्षा करते हुए गोलक पर कार्यरत स्थिर वैद्युत बल के कारण लोलक के दोलन का आवर्तकाल ज्ञात कीजिए । 2

Five point charges, each of charge $+q$ are placed on five vertices of a regular hexagon of side 'l'. Find the magnitude of the resultant force on a charge $-q$ placed at the centre of the hexagon.

OR

A simple pendulum consists of a small sphere of mass m suspended by a thread of length l. The sphere carries a positive charge q. The pendulum is placed in a uniform electric field of strength E directed vertically downwards. Find the period of oscillation of the pendulum due to the electrostatic force acting on the sphere, neglecting the effect of the gravitational force.

7. आरेख में 100 V आपूर्ति से संयोजित पाँच संधारित्रों के नेटवर्क को दर्शाया गया है । नेटवर्क में संचित कुल ऊर्जा परिकलित कीजिए । 2



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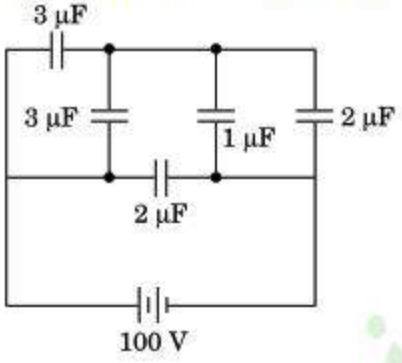
The figure shows a network of five capacitors connected to a 100 V supply. Calculate the total energy stored in the network.



8. 0·5 m लम्बी किसी परिनालिका में प्रति सेन्टीमीटर 10 फेरे हैं तथा इसकी अनुप्रस्थ-काट का क्षेत्रफल 1 cm^2 है । यदि इस परिनालिका से प्रवाहित धारा 0·1 s में 1 A से 2 A हो जाती है, तो इसके सिरों पर प्रेरित वोल्टता परिकलित कीजिए । 2

अथवा

पास-पास फेरों वाली 140 फेरे और 5 cm^2 क्षेत्रफल वाली कोई चपटी अन्वेषी कुण्डली 0·09 T चुम्बकीय क्षेत्र उत्पन्न करने वाले शक्तिशाली चुम्बक के ध्रुवों के बीच रखी है और फिर इसे तीव्रता से इस क्षेत्र से बाहर ले जाया गया है । परिकलित कीजिए

(a) इस कुण्डली से गुज़रने वाले चुम्बकीय फ्लक्स में परिवर्तन, तथा

(b) इस कुण्डली में प्रेरित वि.वा. बल (emf) । 2

A 0·5 m long solenoid of 10 turns/cm has area of cross-section 1 cm^2. Calculate the voltage induced across its ends if the current in the solenoid is changed from 1 A to 2 A in 0·1 s.

OR

A small flat search coil of area 5 cm^2 with 140 closely wound turns is placed between the poles of a powerful magnet producing magnetic field 0·09 T and then quickly removed out of the field region. Calculate

(a) change of magnetic flux through the coil, and

(b) emf induced in the coil.

9. उपाक्षीय किरणों के लिए, यह दर्शाइए कि किसी गोलीय दर्पण की फोकस दूरी उसकी वक्रता त्रिज्या की आधी होती है । 2

For paraxial rays, show that the focal length of a spherical mirror is one-half of its radius of curvature.

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10. दे ब्रॉग्ली परिकल्पना का उपयोग करते हुए किसी इलेक्ट्रॉन के तरंग चित्रण के आधार पर हाइड्रोजन परमाणु की nवीं कक्षा में परिक्रमण करते हुए इलेक्ट्रॉन के कोणीय संवेग के लिए बोर का क्वांटीकरण प्रतिबन्ध प्राप्त कीजिए । *2*

Obtain Bohr's quantisation condition for angular momentum of electron orbiting in n^{th} orbit in hydrogen atom on the basis of the wave picture of an electron using de Broglie hypothesis.

11. समय t के साथ अनक्षयित नाभिकों N के विचरण को दर्शाने के लिए ग्राफ खींचिए । इस ग्राफ का उपयोग करके यह ज्ञात कीजिए कि किसी रेडियोऐक्टिव नाभिक की अर्ध आयु तथा औसत आयु किस प्रकार निर्धारित की जा सकती है । *2*

Plot a graph showing the variation of undecayed nuclei N versus time t. From the graph, find out how one can determine the half-life and average life of the radioactive nuclei.

12. (a) नाभिकीय बलों के दो विभेदनकारी लक्षण लिखिए ।

(b) नीचे दी गई नाभिकीय अभिक्रियाओं को α और β क्षय के लिए पूरा कीजिए : *2*

(i) $^{238}_{92}U \longrightarrow ? + ^{4}_{2}He + Q$

(ii) $^{22}_{11}Na \longrightarrow ^{22}_{10}Ne + ? + \nu$

(a) Write two distinguishing features of nuclear forces.

(b) Complete the following nuclear reactions for α and β decay :

(i) $^{238}_{92}U \longrightarrow ? + ^{4}_{2}He + Q$

(ii) $^{22}_{11}Na \longrightarrow ^{22}_{10}Ne + ? + \nu$

खण्ड स
SECTION C

13. (a) उचित आरेख का उपयोग करते हुए किसी बाह्य विद्युत्-क्षेत्र की उपस्थिति में किसी चालक और किसी परावैद्युत के व्यवहार में अंतर की संक्षेप में व्याख्या कीजिए ।

(b) किसी परावैद्युत के ध्रुवण की परिभाषा लिखिए तथा विद्युत्-क्षेत्र के पदों में किसी रैखिक समदैशिक परावैद्युत के लिए व्यंजक लिखिए । *3*

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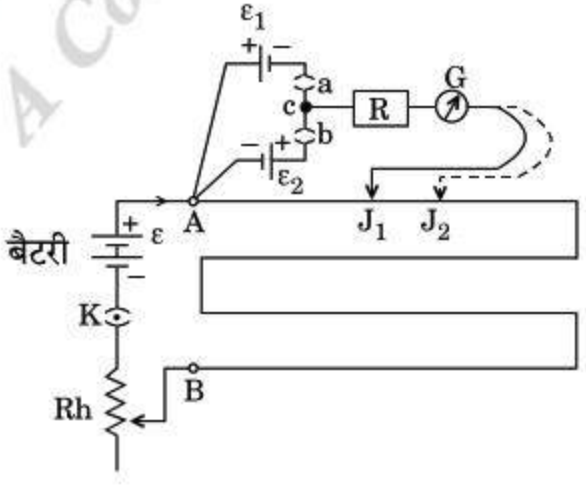
(a) Explain briefly, using a proper diagram, the difference in behaviour of a conductor and a dielectric in the presence of external electric field.

(b) Define the term polarization of a dielectric and write the expression for a linear isotropic dielectric in terms of electric field.

14. 12 तारों, जिनमें प्रत्येक का प्रतिरोध 3 Ω है, को घनीय नेटवर्क में संयोजित किया गया है । इस नेटवर्क के विकर्णत: सम्मुख सिरों को उपेक्षणीय आंतरिक प्रतिरोध की 10 V की बैटरी से जोड़ा गया है । इस नेटवर्क का तुल्य प्रतिरोध तथा इस घन के प्रत्येक कोने के अनुदिश धारा निर्धारित कीजिए । *3*

Twelve wires each having a resistance of 3 Ω are connected to form a cubical network. A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of this network. Determine its equivalent resistance and the current along each edge of the cube.

15. कोई छात्र आरेख में दर्शाए गए पोटेन्शियोमीटर के परिपथ आरेख का उपयोग करता है । (a) पोटेन्शियोमीटर तार से प्रवाहित स्थायी धारा I के लिए वह सेल ε_1 के लिए शून्यविक्षेप स्थिति प्राप्त करता है और ε_2 के लिए यह स्थिति प्राप्त नहीं करता । इस प्रेक्षण के लिए कारण दीजिए और इस परेशानी से पार पाने के लिए सुझाव दीजिए । (b) इस परिपथ में उपयोग किए गए प्रतिरोध R का क्या कार्य है ? इस प्रतिरोध के मान में परिवर्तन का शून्यविक्षेप स्थिति पर क्या प्रभाव होगा ? (c) पोटेन्शियोमीटर की सुग्राहिता में किस प्रकार वृद्धि की जा सकती है ? *3*



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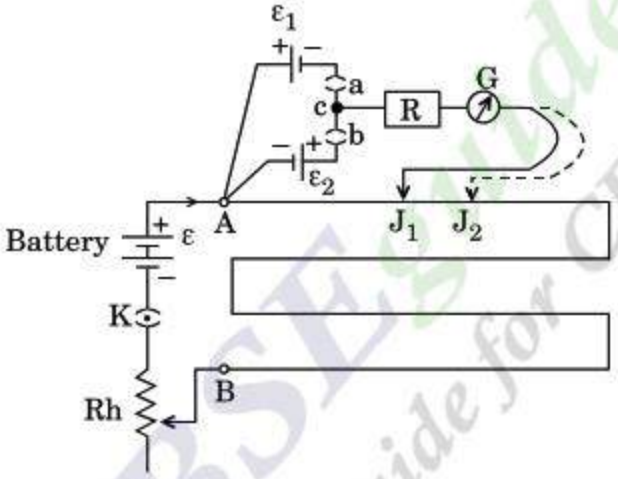
A student uses the circuit diagram of a potentiometer as shown in the figure (a) For a steady current I passing through the potentiometer wire, he gets a null point for the cell ε_1 and not for ε_2. Give reason for this observation and suggest how this difficulty can be resolved. (b) What is the function of resistance R used in the circuit ? How will the change in its value affect the null point ? (c) How can the sensitivity of the potentiometer be increased ?



16. (a) यह दर्शाइए कि एकसमान चुम्बकीय क्षेत्र (B) में मुक्त रूप से निलंबित चुम्बकीय आघूर्ण (m) के किसी चुम्बकीय द्विध्रुव के दोलनों का आवर्तकाल $T = 2\pi\sqrt{\frac{I}{mB}}$ होता है, जहाँ पर I चुम्बकीय द्विध्रुव का जड़त्व आघूर्ण है ।

(b) नीचे दिए गए चुम्बकीय पदार्थों की पहचान कीजिए : *3*

(i) चुम्बकीय पदार्थ जिसकी चुम्बकीय प्रवृत्ति $(\chi_m) = -0{\cdot}00015$ है ।

(ii) चुम्बकीय पदार्थ जिसकी चुम्बकीय प्रवृत्ति $(\chi_m) = 10^{-5}$ है ।

(a) Show that the time period (T) of oscillations of a freely suspended magnetic dipole of magnetic moment (m) in a uniform magnetic field (B) is given by $T = 2\pi\sqrt{\frac{I}{mB}}$, where I is a moment of inertia of the magnetic dipole.

(b) Identify the following magnetic materials :

(i) A material having susceptibility $(\chi_m) = -0{\cdot}00015$.

(ii) A material having susceptibility$(\chi_m) = 10^{-5}$.

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17. (a) किसी चालक जिस पर कोई चुम्बकीय क्षेत्र कार्यरत है में भंवर धाराएँ किस प्रकार उत्पन्न की जाती हैं ?

(b) इनके उपयोगी अनुप्रयोगों के दो उदाहरण दीजिए ।

(c) भंवर धाराओं की हानियों को किस प्रकार कम किया जा सकता है ? *3*

(a) How are eddy currents generated in a conductor which is subjected to a magnetic field ?

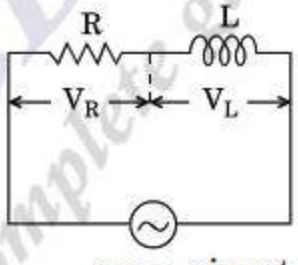
(b) Write two examples of their useful applications.

(c) How can the disadvantages of eddy currents be minimized ?

18. (a) आरेख में दर्शाए अनुसार ac परिपथ में कोई L प्रेरकत्व का प्रेरक तथा R प्रतिरोध का प्रतिरोधक श्रेणी में संयोजित हैं । फ़ेजर आरेख का उपयोग करते हुए, व्याख्या कीजिए कि परिपथ में वोल्टता कला में धारा से अग्र क्यों होगी ।

(b) प्रतिरोधक के सिरों पर विभवान्तर 160 V तथा प्रेरक के सिरों पर विभवान्तर 120 V है । अनुप्रयुक्त वोल्टता का प्रभावी मान ज्ञात कीजिए । यदि परिपथ में प्रभावी धारा 1·0 A है, तो परिपथ की कुल प्रतिबाधा परिकलित कीजिए ।

(c) जब परिपथ में दिष्ट धारा (dc) प्रवाहित की जाती है, तो परिपथ में विभवान्तर क्या होगा ? *3*



$\varepsilon = \varepsilon_0 \sin \omega t$

अथवा

कोई ac परिपथ दो परिपथ अवयवों X और Y के श्रेणी संयोजन से बना है । धारा कला में वोल्टता से $\frac{\pi}{4}$ अग्र है । यदि अवयव X 100 Ω का शुद्ध प्रतिरोध है, तो

(a) परिपथ अवयव Y का नाम लिखिए ।

(b) यदि वोल्टता का rms मान 141 V है, तो धारा का rms मान परिकलित कीजिए ।

(c) यदि ac स्रोत को dc स्रोत से प्रतिस्थापित किया जाए, तो क्या होगा ? *3*

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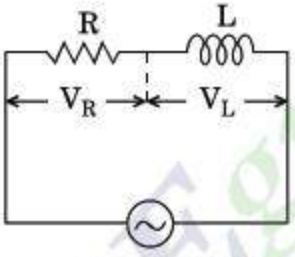
(a) An ac circuit as shown in the figure has an inductor of inductance L and a resistor of resistance R connected in series. Using the phasor diagram, explain why the voltage in the circuit will lead the current in phase.

(b) The potential difference across the resistor is 160 V and that across the inductor is 120 V. Find the effective value of the applied voltage. If the effective current in the circuit be 1·0 A, calculate the total impedance of the circuit.

(c) What will be the potential difference in the circuit when direct current is passed through the circuit ?



$\varepsilon = \varepsilon_0 \sin \omega t$

OR

An ac circuit consists of a series combination of circuit elements X and Y. The current is ahead of the voltage in phase by $\frac{\pi}{4}$. If element X is a pure resistor of 100 Ω,

(a) name the circuit element Y.

(b) calculate the rms value of current, if rms value of voltage is 141 V.

(c) what will happen if the ac source is replaced by a dc source ?

19. निम्नलिखित के लिए उपयोग किए जाने वाले विद्युत्-चुम्बकीय स्पेक्ट्रम के विकिरण का नाम लिखिए : *3*

(a) रेडार

(b) मानव शरीर के भीतरी भागों के फोटोग्राफ के लिए

(c) रात्रि के समय और कूहायन की स्थिति में आकाश का फोटोग्राफ लेने के लिए

प्रत्येक प्रकरण में आवृत्ति परिसर दीजिए ।

Name the radiation of the electromagnetic spectrum which is used for the following :

(a) Radar

(b) To photograph internal parts of human body

(c) For taking photographs of the sky during night and foggy conditions

Give the frequency range in each case.

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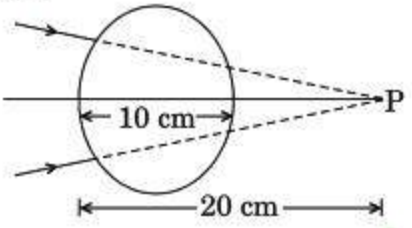
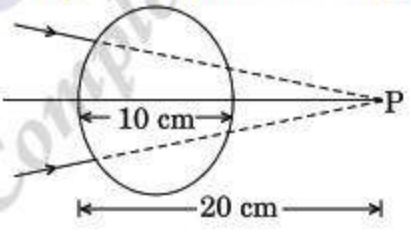
20. वायु में गमन करता अभिसारी प्रकाश पुंज आरेख में दर्शाए अनुसार किसी बिन्दु P पर अभिसारित होता है । जब इस पुंज के पथ में 1·5 अपवर्तनांक के काँच के किसी गोले को रख दिया जाता है, तो प्रतिबिम्ब की नई स्थिति परिकलित कीजिए । बनने वाले प्रतिबिम्ब के लिए किरण आरेख भी खींचिए । *3*



अथवा

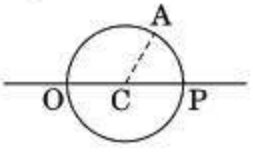
20 cm व्यास के किसी काँच के गोले के पृष्ठ पर अंकित किसी बिन्दु 'O' को, उस स्थिति से जो बिन्दु O के ठीक सम्मुख है काँच से होकर देखा जाता है । यदि काँच का अपवर्तनांक 1·5 है, तो बनने वाले प्रतिबिम्ब की स्थिति ज्ञात कीजिए । प्रतिबिम्ब बनना दर्शाने के लिए किरण आरेख भी खींचिए । *3*

A converging beam of light travelling in air converges at a point P as shown in the figure. When a glass sphere of refractive index 1·5 is introduced in between the path of the beam, calculate the new position of the image. Also draw the ray diagram for the image formed.



OR

A point 'O' marked on the surface of a glass sphere of diameter 20 cm is viewed through glass from the position directly opposite to the point O. If the refractive index of the glass is 1·5, find the position of the image formed. Also, draw the ray diagram for the formation of the image.



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21. (a) व्याख्या कीजिए कि जब कोई अध्रुवित प्रकाश दो पारदर्शी माध्यमों को पृथक् करने वाले अन्तरापृष्ठ पर आपतन करता है, तो वह किस प्रकार ध्रुवित हो जाता है ।

(b) किसी पारदर्शी माध्यम पर ध्रुवण कोण पर हरा प्रकाश आपतन करता है । अपवर्तन कोण 30° है । ज्ञात कीजिए

(i) ध्रुवण कोण, तथा

(ii) माध्यम का अपवर्तनांक । *3*

(a) Explain how an unpolarised light gets polarised when incident on the interface separating the two transparent media.

(b) Green light is incident at the polarising angle on a certain transparent medium. The angle of refraction is 30°. Find

(i) polarising angle, and

(ii) refractive index of the medium.

22. (a) प्रकाश-विद्युत् प्रभाव के संदर्भ में आपतित विकिरणों की आवृत्ति के साथ निरोधी विभव के विचरण को दर्शाने के लिए ग्राफ खींचिए ।

(b) आइंस्टाइन के प्रकाश-विद्युत् समीकरण का उपयोग यह दर्शाने के लिए कीजिए कि इस ग्राफ का उपयोग करके (i) देहली आवृत्ति, तथा (ii) प्लांक नियतांक का निर्धारण किस प्रकार किया जा सकता है । *3*

अथवा

(a) आइंस्टाइन के प्रकाश-विद्युत् समीकरण की सहायता से प्रकाशसंवेदी सतह पर से इलेक्ट्रॉनों के उत्सर्जन को कोई कैसे समझा सकता है ?

(b) ऐलुमिनियम का कार्य फलन 4·2 eV है । यदि 2·5 eV ऊर्जा वाले दो फोटॉन इसकी सतह पर आपतित होते हैं, तो क्या इलेक्ट्रॉनों का उत्सर्जन होगा ? अपने उत्तर की पुष्टि कीजिए ।

(c) प्रकाश-विद्युत् प्रभाव के एक प्रयोग में निरोधी विभव 1·5 V है । उत्सर्जित फोटोइलेक्ट्रॉनों की अधिकतम गतिज ऊर्जा कितनी होगी ? गणना जूल में कीजिए । *3*

(a) Plot a graph to show the variation of stopping potential with frequency of incident radiation in relation to photoelectric effect.

(b) Use Einstein's photoelectric equation to show how from this graph, (i) Threshold frequency, and (ii) Planck's constant can be determined.

OR

(a) How does one explain the emission of electrons from a photosensitive surface with the help of Einstein's photoelectric equation ?

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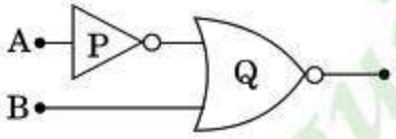
(b) Work function of aluminium is 4·2 eV. If two photons each of energy 2·5 eV are incident on its surface, will the emission of electrons take place ? Justify your answer.

(c) The stopping potential in an experiment on photoelectric effect is 1·5 V. What is the maximum kinetic energy of the photoelectrons emitted ? Calculate in Joules.

23. (a) (i) दिए गए परिपथ में अंकित P और Q तर्क गेटों की सत्यमान सारणी लिखिए ।

(ii) परिपथ के लिए सत्यमान सारणी लिखिए ।



(b) NOR गेट को सार्वत्रिक गेट क्यों माना जाता है ? *3*

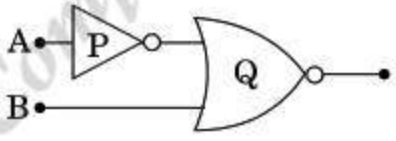
अथवा

(a) व्याख्या कीजिए कि किसी p-n संधि डायोड में विभव प्राचीर किस प्रकार विकसित होती है ।

(b) पश्चदिशिक बायस में किसी p-n संधि डायोड के V-I अभिलाक्षणिक के अध्ययन के लिए परिपथ व्यवस्था खींचिए । इस प्रकरण में V-I अभिलाक्षणिक खींचिए । *3*

(a) (i) Write the truth tables of the logic gates marked P and Q in the given circuit.

(ii) Write the truth table for the circuit.



(b) Why are NOR gates considered as universal gates ?

OR

(a) Explain how a potential barrier is developed in a p-n junction diode.

(b) Draw the circuit arrangement for studying the V-I characteristics of a p-n junction diode in reverse bias. Plot the V-I characteristics in this case.

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24. (a) किसी सिग्नल की बैण्ड चौड़ाई से आपका क्या तात्पर्य है ? इसका महत्त्व लिखिए ।

(b) अनुरूप और अंकीय संचार के बीच विभेदन कीजिए ।

(c) ट्रांसड्यूसर और पुनरावर्तक के कार्य लिखिए । *3*

(a) What do you mean by bandwidth of a signal ? Give its importance.

(b) Differentiate between Analog and Digital communication.

(c) Write the functions of transducer and repeaters.

खण्ड द
SECTION D

25. (a) किसी धारा अवयव के कारण किसी बिन्दु पर चुम्बकीय क्षेत्र को निर्धारित करने वाला नियम लिखिए और उसकी व्याख्या कीजिए । r त्रिज्या के किसी वृत्ताकार धारावाही पाश के कारण अपने केन्द्र पर चुम्बकीय क्षेत्र के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) किसी लम्बे तार पर 1 cm लम्बाई का कोई छोटा धारा अवयव है जो मूल-बिन्दु पर स्थित है तथा जिससे X-अक्ष के अनुदिश 10 A धारा प्रवाहित हो रही है । Y-अक्ष पर इस अवयव से 0·5 m दूरी पर इस धारा अवयव के कारण चुम्बकीय क्षेत्र का परिमाण और दिशा ज्ञात कीजिए । *5*

अथवा

(a) त्रिज्या r की किसी धारावाही कुण्डली के कारण कुण्डली के केन्द्र से दूरी x पर X-अक्ष के अनुदिश चुम्बकीय क्षेत्र के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) आरेख में दर्शाए अनुसार किसी धारावाही सीधे तार, जिससे 5 A धारा प्रवाहित हो रही है, को 2 cm त्रिज्या के अर्धवृत्ताकार चाप की आकृति में मोड़ा गया है । इस चाप के केन्द्र पर चुम्बकीय क्षेत्र का परिमाण और दिशा ज्ञात कीजिए । *5*

(a) State and explain the law used to determine magnetic field at a point due to a current element. Derive the expression for the magnetic field due to a circular current carrying loop of radius r at its centre.

(b) A long wire with a small current element of length 1 cm is placed at the origin and carries a current of 10 A along the X-axis. Find out the magnitude and direction of the magnetic field due to the element on the Y-axis at a distance 0·5 m from it.

OR

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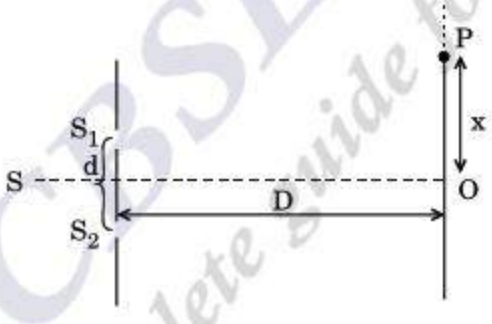
(a) Derive the expression for the magnetic field due to a current carrying coil of radius r at a distance x from the centre along the X-axis.

(b) A straight wire carrying a current of 5 A is bent into a semicircular arc of radius 2 cm as shown in the figure. Find the magnitude and direction of the magnetic field at the centre of the arc.

26. (a) क्या दो स्वतंत्र एकवर्णी प्रकाश स्रोतों द्वारा व्यतिकरण पैटर्न प्राप्त किया जा सकता है ? व्याख्या कीजिए ।

(b) आरेख में दर्शाई गई किसी यंग के द्विझिरी प्रयोग की प्रायोगिक व्यवस्था में केन्द्रीय उच्चिष्ठ (O) पर तीव्रता I_O है । यदि दूरी OP पैटर्न की फ्रिंज-चौड़ाई का एक-तिहाई है, तो यह दर्शाइए कि बिन्दु P पर तीव्रता $\frac{I_O}{4}$ होगी ।



(c) यंग के द्विझिरी प्रयोग में झिरियों के बीच पृथकन 0·5 mm तथा पर्दा झिरियों से 1·0 m दूर स्थित है । यह पाया गया है कि दूसरी काली फ्रिंज से पाँचवीं चमकीली फ्रिंज की दूरी 4·13 mm है । प्रयुक्त प्रकाश की तरंगदैर्घ्य ज्ञात कीजिए । 5

अथवा

(a) तरंगदैर्घ्य λ के प्रकाश का उपयोग करने पर चौड़ाई 'a' की किसी एकल झिरी द्वारा उत्पन्न विवर्तन पैटर्न में पहले निम्निष्ठ के लिए संबंध $a \sin \theta = \lambda$ को व्युत्पन्न कीजिए ।

(b) कारण सहित उल्लेख कीजिए कि केन्द्रीय उच्चिष्ठ की रैखिक चौड़ाई किस प्रकार प्रभावित होगी यदि (i) एकवर्णी पीले प्रकाश को लाल प्रकाश द्वारा प्रतिस्थापित कर दिया जाए, तथा (ii) झिरी और पर्दे के बीच की दूरी में वृद्धि कर दी जाए ?

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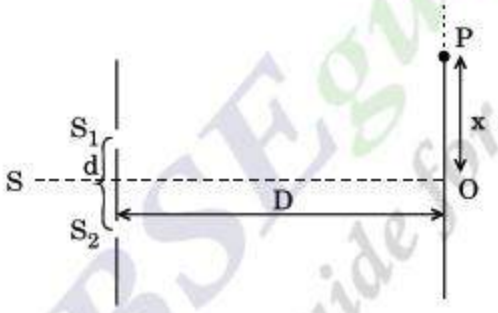
(c) विवर्तन पैटर्न और 1 mm झिरी पृथकन के व्यतिकरण पैटर्न, इन दोनों की प्रायोगिक व्यवस्थाओं में समान तरंगदैर्घ्य के एकवर्णी प्रकाश का उपयोग करने पर विवर्तन पैटर्न के केन्द्रीय उच्चिष्ठ में 10 व्यतिकरण फ्रिंज पाई जाती हैं । यदि दोनों प्रकरणों में झिरी और पर्दे के बीच की दूरी समान है, तो एकल झिरी की चौड़ाई निर्धारित कीजिए । 5

(a) Can the interference pattern be produced by two independent monochromatic sources of light ? Explain.

(b) The intensity at the central maximum (O) in a Young's double slit experimental set-up shown in the figure is I_O. If the distance OP equals one-third of the fringe width of the pattern, show that the intensity at point P, would equal $\frac{I_O}{4}$.



(c) In Young's double slit experiment, the slits are separated by 0·5 mm and screen is placed 1·0 m away from the slit. It is found that the 5th bright fringe is at a distance of 4·13 mm from the 2nd dark fringe. Find the wavelength of light used.

OR

(a) Derive the relation $a \sin \theta = \lambda$ for the first minimum of the diffraction pattern produced due to a single slit of width 'a' using light of wavelength λ.

(b) State with reason, how the linear width of central maximum will be affected if (i) monochromatic yellow light is replaced with red light, and (ii) distance between the slit and the screen is increased.

(c) Using the monochromatic light of same wavelength in the experimental set-up of the diffraction pattern as well as in the interference pattern where the slit separation is 1 mm, 10 interference fringes are found to be within the central maximum of the diffraction pattern. Determine the width of the single slit, if the screen is kept at the same distance from the slit in the two cases.

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27. (a) किसी n-p-n ट्रांज़िस्टर के लिए परिपथ आरेख खींचिए जिसमें उत्सर्जक-आधार संधि अग्र बायसित है तथा आधार-संग्राहक संधि पश्चदिशिक बायसित है । इसकी कार्यविधि का संक्षेप में वर्णन कीजिए ।

व्याख्या कीजिए कि कोई ट्रांज़िस्टर अपनी सक्रिय अवस्था में किस प्रकार अपनी उत्सर्जक-आधार संधि पर निम्न प्रतिरोध दर्शाता है तथा आधार-संग्राहक संधि पर उच्च प्रतिरोध दर्शाता है ।

(b) लोड प्रतिरोध R_L, धारा लब्धि β_a तथा निवेश प्रतिरोध के पदों में CE विन्यास में किसी ट्रांज़िस्टर प्रवर्धक की वोल्टता लब्धि के लिए व्यंजक व्युत्पन्न कीजिए ।

व्याख्या कीजिए कि निवेशी और निर्गत वोल्टताएँ विपरीत कला में क्यों होती हैं । *5*

अथवा

(a) प्रकाश उत्सर्जक डायोड (LED) के रूप में उपयोग किए जाने वाले किसी p-n संधि डायोड का विरचन करते समय जिन महत्त्वपूर्ण विचारों को ध्यान में रखा जाता है उनका उल्लेख कीजिए । यदि किसी LED को दृश्य परिसर में प्रकाश उत्सर्जित करना है, तो LED का बैण्ड अन्तराल किस कोटि का होना चाहिए ? एक परिपथ आरेख खींचिए और इसकी क्रियाविधि की व्याख्या कीजिए ।

(b) LED का V-I अभिलाक्षणिक खींचिए । परम्परागत तापदीप्त लैम्पों की तुलना में LED लैम्पों के दो लाभों का उल्लेख कीजिए । *5*

(a) Draw a circuit diagram of an n-p-n transistor with its emitter-base junction forward biased and base-collector junction reverse biased. Briefly describe its working.

Explain how a transistor in its active state exhibits a low resistance at its emitter-base junction and high resistance at its base-collector junction.

(b) Derive the expression for the voltage gain of a transistor amplifier in CE configuration in terms of the load resistance R_L, current gain β_a and input resistance.

Explain why input and output voltages are in opposite phase.

OR

(a) Write the important considerations which are to be taken into account while fabricating a p-n junction diode to be used as a Light Emitting Diode (LED). What should be the order of band gap of an LED, if it is required to emit light in the visible range ? Draw a circuit diagram and explain its action.

(b) Draw the V-I characteristics of an LED. State two advantages of LED lamps over conventional incandescent lamps.

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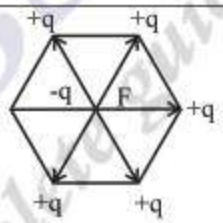
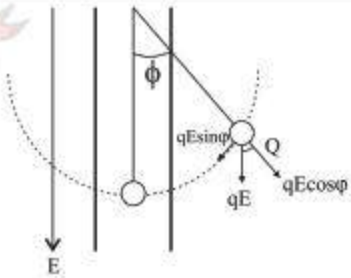
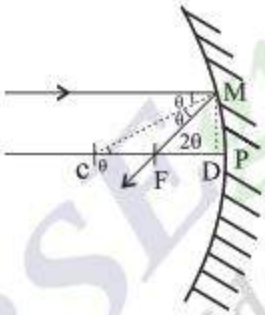
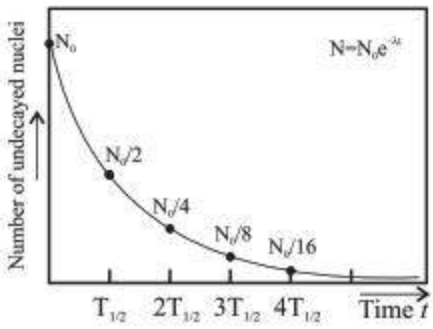
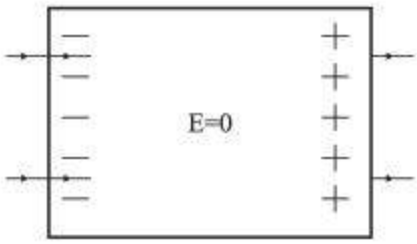
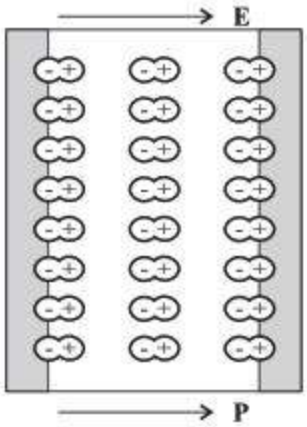
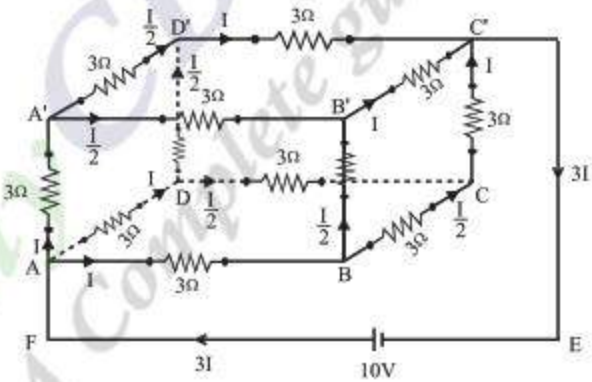
Sl. No.	Value Points / Expected Answers	Marks	Total
	SECTION - A		
Q1.	Sphere A will be negatively charged Sphere B will be positively charged Alternatively- B will be similarly charged to the rod and A will be oppositely charged. OR Sphere will be positively charged. Reason - Electrostatic Induction	½ ½ ½+½ ½ ½	1
Q2.	$57 \times 10^2 \Omega$	1	1
Q3.	$f_0 >> f_e$ Focal length of objective must be much greater than focal length of eyepiece OR Angle of minimum deviation decreases.	 1 1	1
Q4.	(a) Intensity of incident radiation is constant (b) ν_1 is the highest frequency.	½ ½	1
Q5.	It is the process of varying the amplitude of the carrier wave in accordance with the amplitude of the message / modulating signal. (Also accept: Diagrammatic representation of AM.)	1	1
	SECTION - B		
Q6.	i) Diagram(or statement) for justification 1 ii) Net force (expression) 1		
			
	Alternatively The forces due to the charges placed diagonally opposite at the vertices of hexagon, on the charge -q cancel in pairs. Hence net force is due to one charge only. Net Force $\lvert\vec{F}\rvert = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{l^2}$ Ne	1 1	2
	OR		
	I) Diagram ½ ii) Derivation of period of oscillation 1½		
		½	
	Derivation F_r=-qEsinφ (Restoring force) ma=-qEsinφ when φ is small ma = -qEφ	 ½	

Sl. No.	Value Points / Expected Answers	Marks	Total
	$m\frac{d^2x}{dt^2} = -qE\frac{x}{l}$		
	$\frac{d^2x}{dt^2} = -q\frac{E}{m}\frac{x}{l}$	½	
	comparing with equation of linear SHM.		2
	$\frac{d^2x}{dt^2} = -\omega^2 x$		
	$\omega = \sqrt{\frac{qE}{ml}}$		
	$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{ml}{qE}}$	½	
	Alternatively - The student can use angular SHM expression also. Full marks to be awarded for correct answer even without intermediate steps.		
Q7.	i) Calculation of Equivalent capacitance 1 ii) Total Energy 1		
	i) Equivalent capacitance of two 3μF capacitor in parallel C_1=3+3 = 6μF Similarly equivalent capacitance of 1μF and 2μF in parallel $C_2 = 1 + 2 = 3\mu F$	½	
	Equivalent capacitance of C_1 and C_2 in series $C_{12} = \frac{6\times3}{6+3} = 2\mu F$		2
	Net capacitance $C = 2 + 2 = 4\mu F$	½	
	ii) Energy stored $E = ½ CV^2$	½	
	$= ½ \times 4 \times 10^{-6} \times (100)^2$		
	$= 0.02$ J	½	
	[Note: Award the 1 mark for correct calculation in part (ii) if the value of C_{eq} obtained in part (i) is correct]		
Q8.	Formula ½ Calculation of Induced Voltage 1½		
	Induced voltage $\lvert V \rvert = L\frac{dI}{dt}$	½	
	$\therefore \lvert V \rvert = \mu_0 n^2 la \frac{dI}{dt}$	½	
	$= 4\pi\times10^{-7}\times\left(\frac{10}{10^{-2}}\right)^2 \times 0.5 \times 1 \times 10^{-4} \times \frac{(2-1)}{0.1}$	½	2
	$= 6.28 \times 10^{-4}$V or 0.628mV	½	
	OR		
	Calculation of (i) change of magnetic flux 1 (ii) induced emf 1		
	i) $\Delta\phi = \phi_2 - \phi_1 = 0 - NBA\cos\theta$ $= 140 \times 0.09 \times 5 \times 10^{-4} \cos 0 = 63 \times 10^{-4}$ Wb	½	

Sl. No.	Value Points / Expected Answers	Marks	Total
	Alternatively If student assumes that the coil was initially kept with its plane parallel to the field, i.e. $\varphi = 90°$, $\Delta\phi = (0 - 0) = 0$ Wb award 1 mark	1	
	ii) $e = \frac{-\Delta\phi}{\Delta t} = \frac{-63\times10^{-4}}{\Delta t}$ V Alternatively, if the student takes $\Delta\phi = 0$, then e = o,	½+½	
	[Note: Award this 1 mark, If a student writes that induced emf cannot be calculated as value of time interval Δt it is not given.]		2
Q9.	i) Ray Diagram 1 ii) Derivation of relation 1		
		1	
	From ray diagram $\tan\theta = \frac{MD}{CD}$ and $\tan 2\theta = \frac{MD}{FD}$	½	
	for small θ, $\tan\theta \cong \theta$, $\tan 2\theta \cong 2\theta$ $\therefore \frac{MD}{FD} = 2\frac{MD}{CD}$		2
	$FD = \frac{CD}{2} \cong \frac{CP}{2}$ $\therefore f = \frac{R}{2}$	½	
Q10.	Obtaining Bohr's quantization condition using deBroglie hypothesis 2		
	Let λ be the deBroglie wavelength associated with electron orbiting (with speed v) in the with n^{th} orbit (of radius r) in hydrogen atom. $\therefore \lambda = \frac{h}{mv}$	½	
	Also $2\pi r = n\lambda$ $= \frac{nh}{mv}$	½	2
	$\therefore L = mvr = \frac{nh}{2\pi}$	1	

Sl. No.	Value Points / Expected Answers	Marks	Total
Q11.	i) Graph showing decay of radioactive nuclei 1 ii) Determination of half life and average life. 1		
	i) 	1	2
	ii) From figure when $N=\frac{N_0}{2}$ $t = T½$ (half life)	½	
	Average life $\tau = \frac{T½}{0.6931}$	½	
Q12.	i) Two features of nuclear force. ½+½ ii) Completion of equations ½+½		
	i) Any two points given : (Nuclear forces are charge independent, Non central, spin dependent, strong force, short ranged.)	½+½	
	ii) ${}^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He + Q$ (Award this ½ mark even if the student writes the first term as ${}^{234}_{90}X$)	½	2
	${}^{22}_{11}Na \longrightarrow {}^{22}_{10}Ne + {}^{0}_{+1}e + \nu$	½	
	SECTION - C		
Q13.	i) Explanation with diagram 2 ii) Definition of polarization and its expression for linear isotropic dielectric in terms of electric field. 1		
		½	
	For conductor Due to induction the free electrons collect on the left face of slab creating equal positive charge on the right face. Internal electric field is equal and opposite to external field; hence net electric field (inside the conductor) is zero.	½	

Sl. No.	Value Points / Expected Answers	Marks	Total
		½	
	For dielectric Due to alignment of atomic dipoles (permanent or induced) along $\vec{E}$, the net electric field within the dielectric decreases.	½	
ii)	The net dipole moment developed per unit volume in the presence of external electric field is called polarization vector $\vec{P}$.	½	3
	Expression ∴ $\vec{P} = X_e \vec{E}$	½	
Q14.	i) Circuit Diagram ½ ii) Calculation of equivalent resistance 1½ iii) Calculation of Currents 1		
		½	
	Applying loop rule to ABCC'EFA $3I + 3\frac{I}{2} + 3I - 10 = 0$	½	
	$\frac{15}{2} I = 10$ $I = \frac{2\times10}{15} = \frac{20}{15}\ A = \frac{4}{3} A$	½	
	$R_{tot} = \frac{V}{3I} = \frac{10\times15}{3\times20} = 2.5\Omega$	½	
	Current = $I_{AB} (= I_{AA'} = I_{AD} = I_{D'C'} = I_{B'C'} = I_{CC'}) = \frac{4}{3} A$	½	
	$I_{DD'} (= I_{A'B'} = I_{A'D'} = I_{DC} = I_{BC} = I_{BB'}) = \frac{2}{3} A$	½	3

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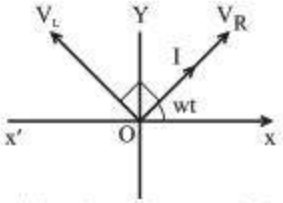
Sl. No.	Value Points / Expected Answers	Marks	Total
Q15.	i) Reason for observation, resolving difficulty ½+½ ii) Stating function of resistance, effect on null point ½+½ iii) Method of increasing sensitivity 1		
	a) Reason :		
	Both ε_1 and ε have positive terminal connected at A whereas negative terminal of E_2 is connected to A.	½	
	By interchanging the terminal of ε_2, the difficulty can be resolved	½	
	b) Resistance R protects the galvanometer by reducing the current flowing through it.	½	3
	Null point position remains unaffected.	½	
	c) Sensitivity can be increased by : Increasing the length of potentiometer / reducing the value of ε / increasing resistance of rheostat / reducing value of current / decreasing value of potential gradient. (Any one reason)	1	
Q16.	i) Derivation of $T = 2\pi\sqrt{\frac{I}{mB}}$ 1 ii) Identification 1+1		
	a) Restoring torque $\tau = -mB\sin\varphi = -mB\,\varphi$ (for small φ)	½	
	$\tau = I\frac{d^2\varphi}{dt^2} = -mB\varphi$		
	$\frac{d^2\varphi}{dt^2} = \frac{-mB}{I}\varphi$		
	Comparing with equation of angular SHM		3
	$\frac{d^2\varphi}{dt^2} = -\omega^2\varphi$		
	$\omega = \sqrt{\frac{mB}{I}}$		
	$T = 2\pi\sqrt{\frac{I}{mB}}$	½	
	b) I) diamagnetic	1	
	ii) Para magnetic	1	
Q17.	i) Generation of Eddy Current 1 ii) Two examples of application ½+½ iii) Method of minimizing 1		
	a) When the magnetic flux linked with a conductor changes with time, induced currents are set up inside the conductor.	1	3
	b) Induction furnace / Induction stove/Induction breaks/dead beat galvanometer (any two)	½+½	
	c) By lamination/cutting shots (any one) eddy current can be minimized.	1	

Sl. No.	Value Points / Expected Answers	Marks	Total
Q18.	i) Explanation using phasor diagram 1 ii) Calculation of impedance 1½ iii) Calculation of potential difference ½		
			
	a) From phasor diagram it is clear that V_R is in phase with I and V_L is ahead of I in phase by $\pi/2$. Hence the resultant voltage (= voltage in the circuit) will lead V_R and, therefore, the current in the circuit.	1	
	b) Let V be the effective potential difference across L-R circuit, therefore $V = \sqrt{V_R^2 + V_L^2} = \sqrt{(160)^2 + (120)^2} = 200V$	½+½	
	∴ Impedance of the circuit, $Z = \frac{V}{I} = \frac{200}{1} = 200\Omega$	½	
	c) For d.c. (constant voltage source) $V_L = 0$, therefore Potential difference in the circuit = V_R = potential difference across the resistor (Alternatively, if the student takes the d.c. also as 1A, the potential difference will be = 160V = V_R)	½	3
	OR		
	i) Naming the circuit element Y ½ ii) Calculation of r.m.s value of current 1½ iii) Effect of replacing a.c source by d.c source 1		
	a) Y is a capacitor.	½	
	b) Phase angle, $\varphi = \pi/4$, Also $\cos\varphi = \frac{R}{Z}$	½	
	$\Rightarrow Z = \frac{R}{\cos\phi} = \frac{R}{\cos(\pi/4)} = \frac{100}{1/\sqrt{2}} = 100\sqrt{2} = 141.4\Omega$	½	
	$I_{r.m.s} = \frac{V_{r.m.s}}{Z} = \frac{141V}{141.4\Omega} \cong 1A$	½	
	c) The current becomes zero.	1	
Q19.	i) Naming the three radiations ½+½+½=1½ ii) Writing their frequency ranges ½+½+½=1½		
	a) Microwaves $\nu = 10^{10}$ Hz to 10^{12} Hz	½ ½	
	b) x-rays $\nu = 10^{16}$ Hz to 10^{20} Hz	½ ½	
	c) Infrared $y = 10^{12}$ Hz to 10^{14} Hz	½ ½	3

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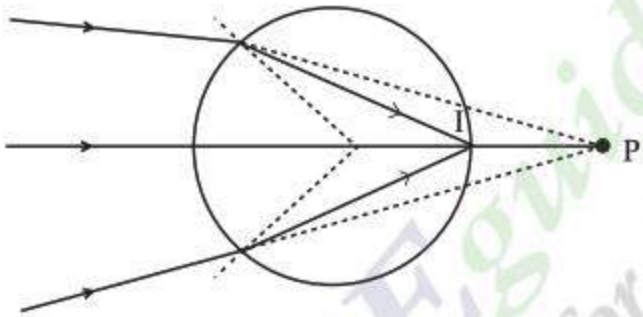
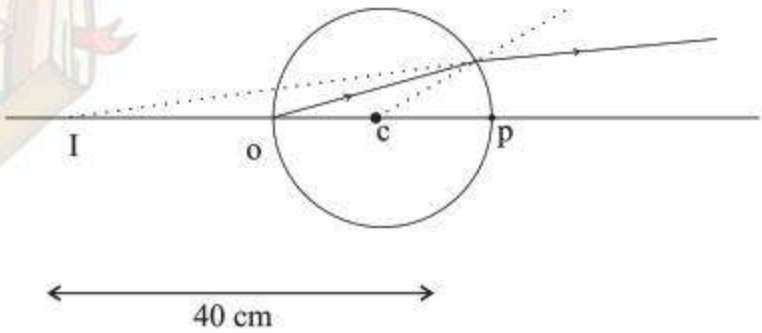
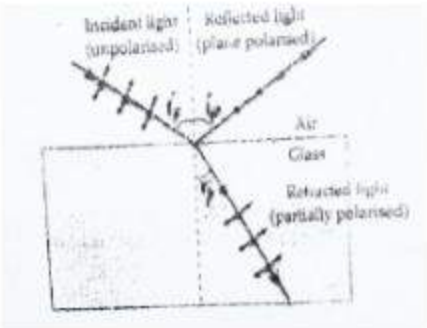
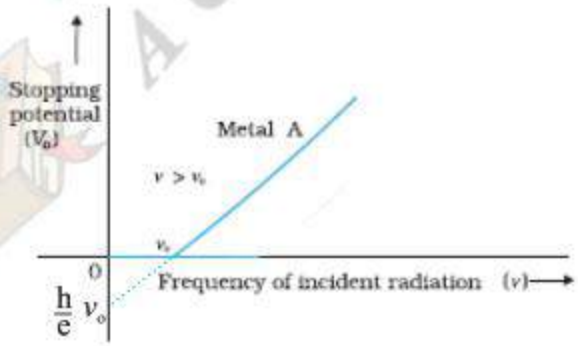
Sl. No.	Value Points / Expected Answers	Marks	Total
Q20.	i) Calculation of new image position 2 ii) Ray diagram 1		
	a) $u = 20cm, n_2=1.5, n_1 = 1, R = 5cm$		
	Using $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	½	
	$\frac{1.5}{v} - \frac{1}{20} = \frac{1.5-1}{5}$	1	
	$v = 10$ cm	½	
		1	
	OR		
	Formula - 1 substitution and calculation - 1 Ray diagram - 1		3
	$\frac{n_1}{-u} + \frac{n_2}{v} = \frac{n_2 - n_1}{R}$	1	
	$\frac{1.5}{20} + \frac{1}{v} = \frac{1-1.5}{-10}$	½	
	$v = -40$cm	½	
		1	

Sl. No.	Value Points / Expected Answers	Marks	Total
Q21.	a. Diagram - ½ Explaination - 1 b. Calculation of (i) Polarizing angle - ½ (ii) Refractive index - 1		
a.		½	
	When unpolarized light propagates from a rarer into a denser medium, it gets partly reflected and partly refracted. If the reflected and refracted lights are perpendicular to each other, the reflected light gets polarized.	1	
	(Alternatively if the student explains using Brewster's law award full marks.)		
b.	(i) $i_p = 90 - r_p$ $i_p = 90 - 30 = 60°$	½	
	(ii) $\mu = \tan i_p = \tan 60° = \sqrt{3}$	½+½	3
Q22.	a) Graph showing variation of stopping potential with frequency - 1 b) Showing the determination of (i) Threshold frequency - 1 (ii) Planck's constant (from the graph) - 1		
a.		1	
	b. From Einstein's Equation $eV_0 = h\nu - h\nu_0$ $V_0 = \frac{h}{e}\nu - \frac{h}{e}\nu_0$	½	

Sl. No.	Value Points / Expected Answers	Marks	Total
	comparing $y = mx + c$		
	(i) Threshold frequency ν_o is the intercept along ν axis.	½	
	(Alternatively, intercept on V_o axis, $c = \frac{h}{e}\ \nu_o$ $\nu_o = \frac{ec}{h}$)		
	(ii) Planck's constant h = e x slope	1	
	OR		3
	a. Explanation of emission of electron from a photosensitive surface - 1 b. Explanation and justification - 1 c. Finding the maximum KE - 1		
	a. When a photon of the energy $h\nu$ is absorbed by an electron in the photosensitive material, a part of the energy absorbed is used up in liberating it from the surface (the work function). The remaining energy appears as KE of the photoelectron.	1	
	Alternatively: $K_{max} = h\nu - \phi_o$ if $h\nu \geq \phi_o$, k_{max} is positive and electron is emitted		
	b. Emission of electron will not take place. Energy $h\nu$, of a single photon, is less than the work function ϕ_o	½ ½	
	(Alternatively - $k_{max} = h\nu - \phi_o$ $h\nu < \phi_o$ so k_{max} is negative; Hence no emission will take place.)		
	c. $V_o = 1.5$ V $k_{max} = eV_o = 1.6 \times 10^{-19} \times 1.5 = 2.4 \times 10^{-19}$ J	1	
	[If a student just writes, $k_{max} = 1.5$ eV award ½ mark]		
Q23.	a. (i) Truth tables for P and Q - ½ + ½ (ii) Truth tables for circuit - 1 b. Explanation for why NOR gates are considered as universal gates - 1		

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Sl. No.	Value Points / Expected Answers	Marks	Total

a. P

(I)

A	Y
0	1
1	0

Q

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

½+½

(ii)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	0

1

b. All basic logic gates can be realized by using NOR gates 1

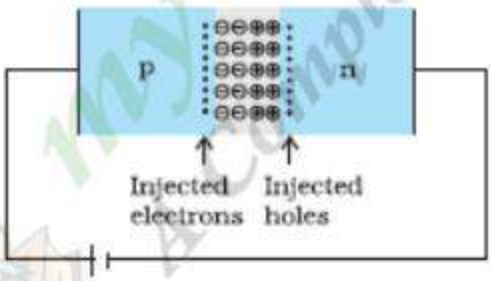
(Also accept if the student draws the diagrams for getting OR & AND gates using NOR gates.)

3

OR

a. Formation of potential barrier (with diagram) - 1½
b. Circuit diagram and plotting graph - 1½

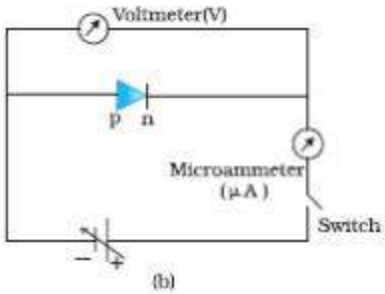
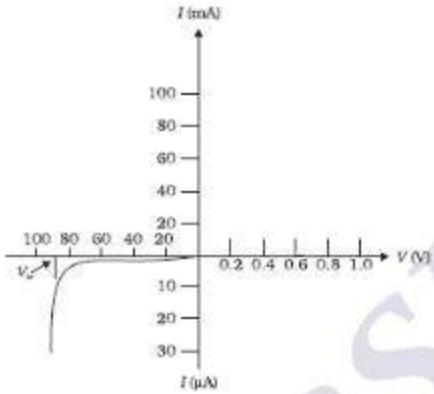
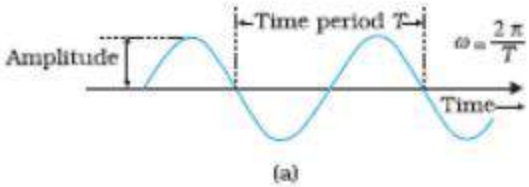
a.

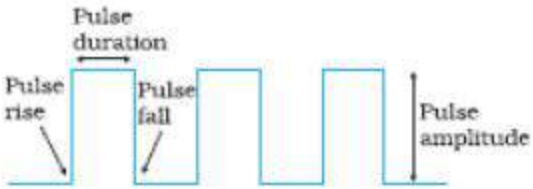
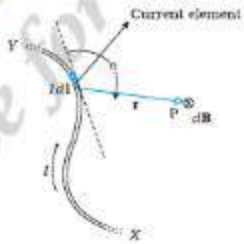
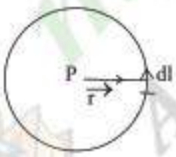


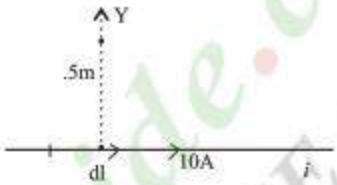
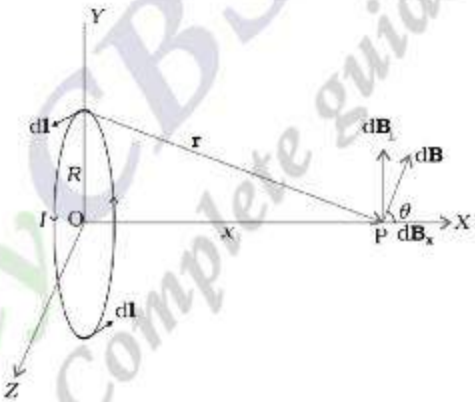
½

During the formation of p - n junction diode: due to the concentration gradient across p and n sides of a diode, holes diffuse from p side to n side and electrons diffuse from n side to p side giving rise to development of immobile positive charges on the n side and the negative charges on the p side across the junction. Thus a potential barrier is formed at the junction. 1

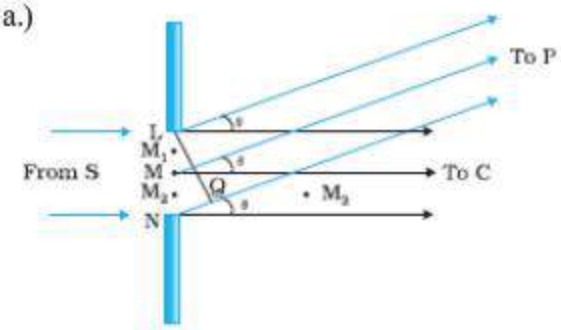
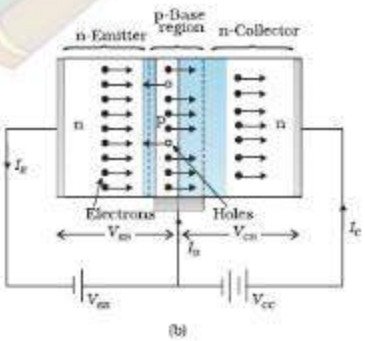
Alternatively: if a student explains with depletion region, award this 1 mark.

Sl. No.	Value Points / Expected Answers	Marks	Total
	b. 	1	
	c. 	½	
Q24.	a. Meaning of bandwidth and importance - 1 b. Differentiation between analog & Digital signal - 1 c. Functions of transducers and repeaters - 1		
	a. Bandwidth of a signal is the range over which the frequencies in that signal vary.	½	
	(Also accept bandwidth is the frequency range over which an equipment/device operates)		
	The knowledge of bandwidth helps in designing equipment used in communication/essential for communication.	½	
	b. In digital communication, digital signals are used which have two discrete current or voltage values in a signal.	½	
	Analog signals are used which have continuous current or voltage values in a signal.	½	3
	Alternatively, if a student draws the diagram of the digital signals and analog signals give these (½+½) mark.		
			

Sl. No.	Value Points / Expected Answers	Marks	Total
	 (b)		
	c. A transducer converts one from of energy into another. A repeater enhances the range of a communication system.	½ ½	
	SECTION - D		
Q25.	a. Statement of the law and expression for the magnetic field - 1+2 b. Finding the magnitude and direction of magnetic field - 1½ +½		
	a. According to Biot Savart law, the magnetic field due to a current element is given by $\vec{dB} = \frac{\mu_0}{4\pi} I \frac{\vec{dl} \times \vec{r}}{[\vec{r}]^3}$ 	1	
	Alternatively award this 1 mark if a student makes statement of Biot Savart law.		
	Derivation of magnetic field 	½	
	Magnetic field due to current element dl $\vec{dB} = \frac{\mu_0}{4\pi} I \frac{\vec{dl} \times \hat{r}}{[\vec{r}]^2}$ where $\hat{r}$ is a unit vector along $\vec{r}$ $\vec{r} \perp \vec{dl}$		
	Direction of $\vec{dB}$ is perpendicular, pointing outward.	½	

Sl. No.	Value Points / Expected Answers	Marks	Total
	∴ Field due to the whole loop		
	$\left\lvert\vec{B}\right\rvert = \int dB = \frac{\mu_o I}{4\pi r^2}\int dl = \frac{\mu_o I}{4\pi r^2} \times 2\pi r$	½	
	$\left\lvert\vec{B}\right\rvert = \frac{\mu_o I}{2r}$	½	5
	b. 		
	$\left\lvert\vec{dB}\right\rvert = \frac{\mu_o I}{4\pi}\frac{dl\sin\theta}{[\vec{r}]^2}$	½	
	$= \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{10 \times (1\times10^{-2}) \times \sin 90^0}{(0.5)^2}$	1	
	$= 4\times10^{-8} T$	½	
Q25.	OR		
	a) Derivation of expression with diagram 3 b) Calculation of magnitude of magnetic field at the center of the arc. 1½ Direction of field ½		
		1	
	According to Biot Savart law		
	$\left\lvert\vec{dB}\right\rvert = \frac{\mu_0}{4\pi}\frac{I\,dl\sin 90^0}{\lvert\vec{r_1}\rvert^2}$		
	Where $r_1 = \sqrt{x^2 + r^2}$		
	$\left\lvert\vec{dB}\right\rvert = \frac{\mu_0}{4\pi}\frac{I\,dl}{(x^2+r^2)^{\frac{3}{2}}}$	½	
	Direction of $\vec{dB}$ is perpendicular to $\vec{dl}$ and $\vec{r_1}$.		5
	It has components dB_x and $dB_\perp$. The components $dB_\perp$ due to the whole coil cancel out in pairs.	½	
	Net field B = $\int dB_x = \int dB\cos\theta$		

Sl. No.	Value Points / Expected Answers	Marks	Total
	$\vec{B} = \frac{\mu_0 I r^2}{2(r^2+x^2)^{\frac{3}{2}}}\hat{i}$	1	
	b) $B = \frac{\mu_0 I}{4r}$	½	
	$= \frac{4\pi \times 10^{-7} \times 5}{4 \times 2 \times 10^{-2}}$	½	
	$= 7.85 \times 10^{-5}$ T	½	
	The field is directed inwards perpendicular to the plane of the page.	½	
Q26.	i) Production of Interference pattern and explanation. 1+1 ii) Obtaining expression for intensity at the point P 1½ iii) Calculating wavelength of light 1½		
	a) No. Sustained interference pattern cannot be obtained	1	
	Light waves emitted from a source undergoes abrupt phase changes in times of the order of 10^{-10}s. So light from two independent sources will not have fixed phase relationship and will be incoherent.	½+½	
	b) $x = \frac{\beta}{3}$, path difference $= \frac{\lambda}{3}$	½	
	phase diff $= \frac{2\pi}{3}$		
	$I = I_0 \cos^2 \frac{\phi}{2}$	½	
	$I = I_0 \cos^2\left(\frac{2\pi}{3\times 2}\right) = I_0 \cos^2\left(\frac{\pi}{3}\right)$		
	$I = I_0\left(\frac{1}{4}\right) = \frac{I_0}{4}$	½	
	c) Distance of 5th bright fringe from 2nd dark fringe		
	$x = \frac{5\lambda D}{d} - \frac{3\lambda D}{2d} = \frac{7}{2}\frac{\lambda D}{d}$	½	5
	$\lambda = \frac{2xd}{7D} = \frac{2\times 4.13\times 10^{-3}\times 0.5\times 10^{-3}}{7\times 1}$	½	
	$\lambda = 0.59 \times 10^{-6}$m $= 5900$ Å	½	
	OR		
	i) Derivation of relation 2 ii) Effect on linear width of central maximum ½+½ iii) Determination of slit width 2		

Sl. No.	Value Points / Expected Answers	Marks	Total
	a.) 	½	
	From diagram path difference between the waves from L and N $= a \sin\theta$	½	
	When first minimum is obtained at P then path difference $= \lambda$	½	
	[imagine the slit be divided into two halves, for each wavelets from first half of the slit has a corresponding wavelet from second half of the slit differing by a path of $\frac{\lambda}{2}$ and cancel each other]		
	Condition for first minimum		
	$\therefore\ \lambda = a \sin\theta$		
	b.) $\beta_{cm} = \frac{2\lambda D}{d}$	½	5
	(i) increases	½	
	(ii) increases	½	
	c.) $10\frac{\lambda}{d} = 2\frac{\lambda}{a}$	1	
	$a = \frac{d}{5} = 0.2\text{mm}$	1	
Q27.	a. Circuit diagram and its working - 2 Explanation of low and high resistance at input and output respectively - 1 b. Derivation of voltage gain - 1½ Input and output phase relation. - ½		
	a. 	1	

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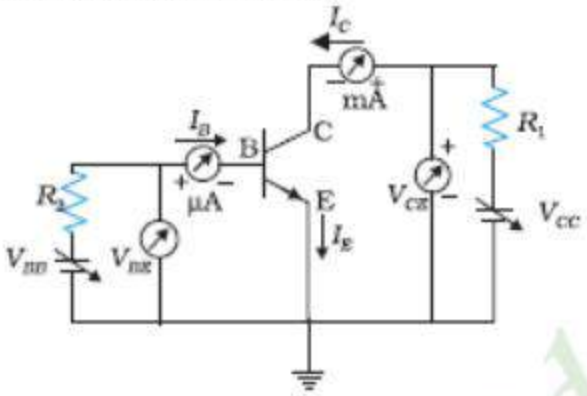
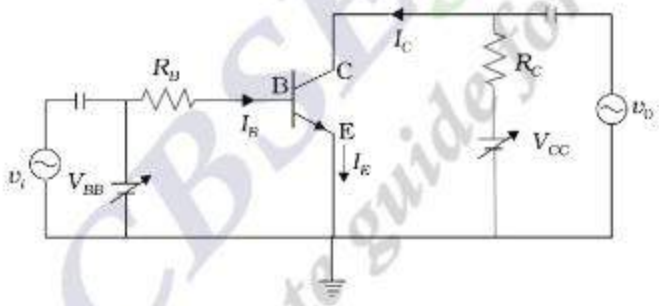
Sl. No.	Value Points / Expected Answers	Marks	Total
	(Also accept the following circuit diagram. )		
	When Emitter Base junction is forward biased, electron from emitter enter the base where a few free charge carriers combine with the holes present in the base. As base is thin, most of the electron go into the collector, since collector junction is reverse biased, it gives rise to a collector current.	1	
	Since Emitter-Base junction is forward biased, input resistance is low and base-collector is reversed biased, so output resistance is high.	½+½	
b.		1	
	Applying Kirchoff's loop rule to input loop and taking variation		
	$\Delta V_{BE} = \Delta I_B (R_B + r_i)$ .....(1)		
	Output loop and taking variations		
	$\Delta V_{CE} = -R_L \Delta I_C$ .....(2)		
	Voltage gain, $A_V = \frac{v_0}{v_i} = \frac{\Delta V_{CE}}{\Delta V_{BE}} = \frac{R_L \Delta I_C}{\Delta I_B (R_B + r_i)} = -\beta_{ac} \frac{R_L}{r}$		
	Where, $R_B + r_i = r$ .....(3)		
	and $\beta_{a.c}$ = Current gain in C.E. $= \frac{\Delta I_C}{\Delta I_B}$	½	
	The negative sign in equation (3) indicates that the input and output voltages are in opposite phase.	½	5

OR

a)	Two considerations for fabricating p-n junction diode used as LED	1
	Order of band gap	1
	Circuit diagram and action	1
b)	V-I characteristics of LED	1
	Two advantages of LED lamps over conventional lamps	½+½

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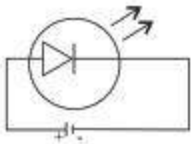
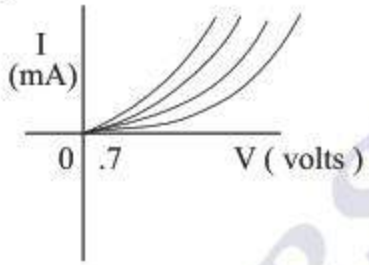
	Marks	Total
a) Important fabricating consideration i) Heavily doped ii) Encapsulated with transparent cover.	½+½	
For visible light: order of band gap for LED = 1.8 eV to 3eV	1	
	½	
When the diode is forward biased, electron are sent from n side to p side and holes are sent from p side to n side and at the junction boundary, the excess minority carrier recombines with the majority carriers releasing energy in the form of photons.	½	
	1	
Two advantage of LED over ordinary Lamps Low operational voltage/Less power consumption / fast action / No warm up time required / Nearly monochomatic / Long life / ruggedness / fast switching capacity (Any two)	½+½	