SET – 2

Series : GBM/1

कोड नं.
Code No. 55/1/2

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 **16** हैं ।
- प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए कोड नम्बर को छात्र उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।
- कृपया जाँच कर लें कि इस प्रश्न-पत्र में **26** प्रश्न हैं ।
- **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, प्रश्न का क्रमांक अवश्य लिखें ।**
- इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जायेगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
- Please check that this question paper contains **16** printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **26** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 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
Time allowed : 3 hours

अधिकतम अंक : 70
Maximum Marks : 70

सामान्य निर्देश :

(i) ***सभी** प्रश्न अनिवार्य हैं । इस प्रश्न-पत्र में कुल 26 प्रश्न हैं ।*

(ii) *इस प्रश्न-पत्र के **5** भाग हैं : खण्ड-**अ**, खण्ड-**ब**, खण्ड-**स**, खण्ड-**द** और खण्ड-**य** ।*

(iii) *खण्ड-**अ** में **5** प्रश्न हैं, प्रत्येक का **1** अंक है । खण्ड-**ब** में **5** प्रश्न हैं, प्रत्येक के **2** अंक हैं । खण्ड **स** में **12** प्रश्न हैं, प्रत्येक के **3** अंक हैं । खण्ड **द** में **4** अंक का एक मूल्याधारित प्रश्न है और खण्ड **य** में **3** प्रश्न हैं, प्रत्येक के **5** अंक हैं ।*

(iv) *प्रश्न-पत्र में समग्र पर कोई विकल्प नहीं है । तथापि, दो अंकों वाले एक प्रश्न में, तीन अंकों वाले एक प्रश्न 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 = 9.1×10^{-31} kg

न्यूट्रॉन का द्रव्यमान = 1.675×10^{-27} kg

प्रोटोन का द्रव्यमान = 1.673×10^{-27} kg

आवोगाद्रो संख्या = 6.023×10^{23} प्रति ग्राम मोल

बॉल्ट्ज़मान नियतांक = 1.38×10^{-23} JK^{-1}

General Instructions :

(i) ***All*** *questions are compulsory. There are* ***26*** *questions in all.*

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

(iii) *Section* ***A*** *contains* ***five*** *questions of* ***one*** *mark each, Section* ***B*** *contains* ***five*** *questions of* ***two*** *marks each, Section* ***C*** *contains* ***twelve*** *questions of* ***three*** *marks each, Section* ***D*** *contains* ***one*** *value based question of* ***four*** *marks and Section* ***E*** *contains* ***three*** *questions of* ***five*** *marks each.*

(iv) *There is no overall choice. However, an internal choice has been provided in* ***one*** *question of* ***two*** *marks,* ***one*** *question of* ***three*** *marks and all the* ***three*** *questions of* ***five*** *marks weightage. You have to attempt only* ***one*** *of the choices in such questions.*

(v) *You may use the following values of physical constants wherever necessary :*

$c = 3 \times 10^8$ 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 = 9.1×10^{-31} kg

Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

Avogadro's number = 6.023×10^{23} per gram mole

Boltzmann constant = 1.38×10^{-23} JK^{-1}

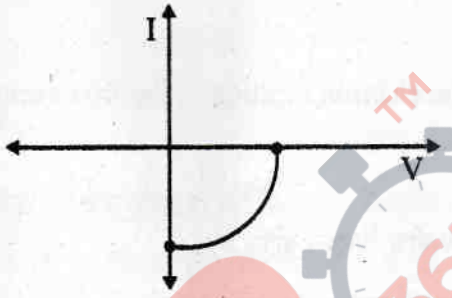
खण्ड – अ

SECTION – A

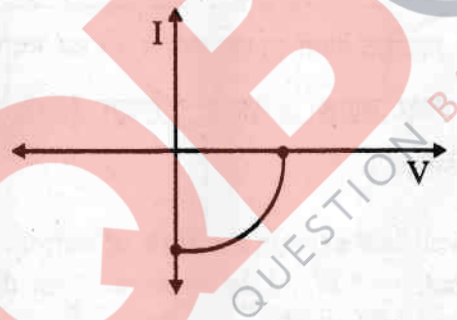
1. किसी स्थान पर पृथ्वी के चुम्बकीय क्षेत्र का क्षैतिज घटक B तथा नमन कोण 60° है । विषुवद्-वृत पर पृथ्वी के चुम्बकीय क्षेत्र का क्षैतिज घटक क्या है ? 1

At a place, the horizontal component of earth's magnetic field is B and angle of dip is 60°. What is the value of horizontal component of the earth's magnetic field at equator ?

2. उस संधि डायोड का नाम लिखिए जिसका I-V अभिलाक्षणिक नीचे दिए अनुसार खींचा गया है : 1



Name the junction diode whose I-V characteristics are drawn below :



3. किसी धातु के गोले को दिया गया आवेश क्या इस पर निर्भर करता है कि गोला ठोस है अथवा खोखला ? अपने उत्तर के लिए कारण दीजिए । 1

Does the charge given to a metallic sphere depend on whether it is hollow or solid ? Give reason for your answer.

4. विद्युत और चुम्बकीय क्षेत्रों द्वारा निर्वात में विद्युत चुम्बकीय तरंगों की चाल किस प्रकार निर्धारित की जाती है ? 1

How is the speed of em-waves in vacuum determined by the electric and magnetic fields ?

5. कोई लम्बा सीधा धारावाही तार किसी वृत्ताकार पाश के केन्द्र से अभिलम्बवत गुजरता है । यदि इस तार से प्रवाहित धारा में वृद्धि होती है, तो क्या पाश में कोई emf प्रेरित होगी । अपने उत्तर की पुष्टि कीजिए । 1

A long straight current carrying wire passes normally through the centre of circular loop. If the current through the wire increases, will there be an induced emf in the loop ? Justify.

खण्ड – ब

SECTION – B

6. हाइड्रोजन परमाणु की प्रथम उत्तेजित अवस्था में कक्षा में परिक्रमा करने वाले इलेक्ट्रॉन की तरंगदैर्ध्य ज्ञात कीजिए । 2

Find the wavelength of the electron orbiting in the first excited state in hydrogen atom.

7. किसी ट्रांसड्यूसर और रिपीटर के बीच विभेदन कीजिए । 2

Distinguish between a transducer and a repeater.

8. जब किसी संधारित्र को बैटरी से आवेशित किया जा रहा होता है, तो इस संधारित्र से प्रवाहित धारा के विषय में ऐम्पियर-मैक्सवैल नियम किस प्रकार व्याख्या करता है ? विद्युत फ्लक्स की दर के परिवर्तन के पदों में विस्थापन धारा के लिए व्यंजक लिखिए । 2

How does Ampere-Maxwell law explain the flow of current through a capacitor when it is being charged by a battery ? Write the expression for the displacement current in terms of the rate of change of electric flux.

9. निकटतम उपगमन की दूरी की परिभाषा लिखिए । किसी पतली गोल्ड की पन्नी पर गतिज ऊर्जा K के किसी α-कण द्वारा बमबारी की गयी है । निकटतम उपगमन की दूरी r है । इससे दो गुनी गतिज ऊर्जा के α-कण के लिए निकटतम उपगमन की दूरी क्या होगी ? 2

अथवा

रदरफोर्ड के परमाणु के नाभिकीय मॉडल की दो महत्त्वपूर्ण सीमाएँ लिखिए ।

Define the distance of closest approach. An α-particle of kinetic energy 'K' is bombarded on a thin gold foil. The distance of the closest approach is 'r'. What will be the distance of closest approach for an α-particle of double the kinetic energy ?

OR

Write two important limitations of Rutherford nuclear model of the atom.

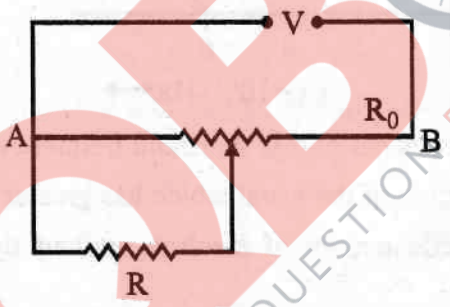
10. किसी टेलीस्कोप के अभिदृश्यक की फोकस दूरी अधिक और द्वारक अधिक क्यों होना चाहिए ? अपने उत्तर की पुष्टि कीजिए । 2

Why should the objective of a telescope have large focal length and large aperture ? Justify your answer.

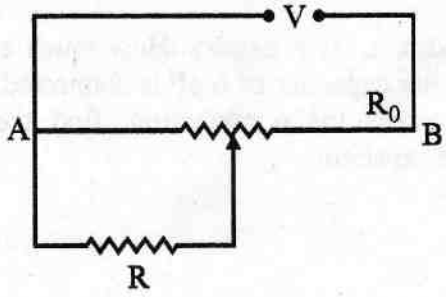
खण्ड-स

SECTION – C

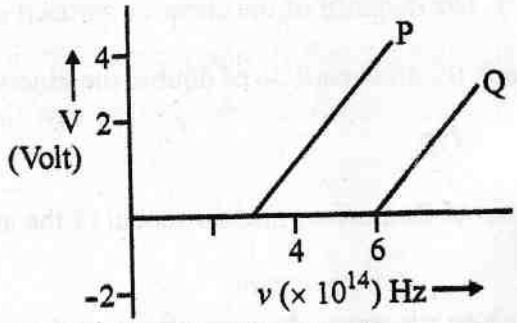
11. किसी प्रतिरोध R को पोटैन्शियोमीटर से धारा प्राप्त हो रही है । पोटैन्शियोमीटर के तार AB का कुल प्रतिरोध R_0 है । इस पोटैन्शियोमीटर को वोल्टता V की आपूर्ति की गयी है । R के सिरों पर वोल्टता के लिए व्यंजक व्युत्पन्न कीजिए जबकि सर्पी सम्पर्क पोटैन्शियोमीटर तार के मध्य में हैं । 3



A resistance of R draws current from a potentiometer. The potentiometer wire, AB, has a total resistance of R_0. A voltage V is supplied to the potentiometer. Derive an expression for the voltage across R when the sliding contact is in the middle of potentiometer wire.



12. प्रकाश-विद्युत प्रभाव के किसी अध्ययन में निरोधी विभव V और आपतित विकिरणों की आवृत्ति ν के बीच ग्राफ, दो भिन्न धातुओं P और Q के लिए नीचे दर्शाए गए हैं :

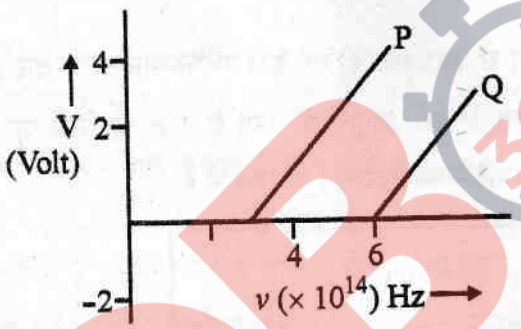


(i) इन दोनों धातुओं में से किसकी देहली आवृत्ति अधिक है ?

(ii) जिस धातु का कार्यफलन अधिक है उसके लिए कार्यफलन निर्धारित कीजिए ।

(iii) इस धातु के लिए 8×10^{14} Hz आवृत्ति के प्रकाश द्वारा उत्सर्जित इलेक्ट्रॉनों की अधिकतम गतिज ऊर्जा ज्ञात कीजिए । 3

In the study of a photoelectric effect the graph between the stopping potential V and frequency ν of the incident radiation on two different metals P and Q is shown below :



(i) Which one of the two metals has higher threshold frequency ?

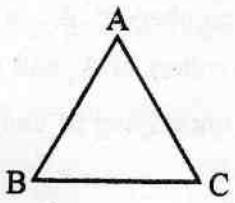
(ii) Determine the work function of the metal which has greater value.

(iii) Find the maximum kinetic energy of electron emitted by light of frequency 8×10^{14} Hz for this metal.

13. 12 pF के किसी संधारित्र को 50 V बैटरी से संयोजित किया गया है । इस संधारित्र में संचित स्थिर वैद्युत ऊर्जा कितनी है ? यदि इस संधारित्र के साथ श्रेणी में कोई 6 pF का अन्य संधारित्र जोड़कर इस संयोजन के सिरों पर इसी बैटरी को संयोजित किया जाए तो प्रत्येक संधारित्र में संचित आवेश और उसके सिरों पर विभवान्तर ज्ञात कीजिए । 3

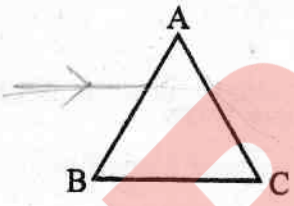
A 12 pF capacitor is connected to a 50 V battery. How much electrostatic energy is stored in the capacitor ? If another capacitor of 6 pF is connected in series with it with the same battery connected across the combination, find the charge stored and potential difference across each capacitor.

14. (i) किसी समबाहु काँच के प्रिज्म के फलक AB पर आपतित कोई प्रकाश किरण 30° का न्यूनतम विचलन दर्शाती है । प्रिज्म में प्रकाश की चाल परिकलित कीजिए । 3



(ii) फलक AB पर वह आपतन कोण ज्ञात कीजिए जिसके लिए निर्गत किरण फलक AC के अनुदिश संस्पर्श करती है ।

(i) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism.



(ii) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.

15. (i) किसी रेडियोएक्टिव नाभिक 'A' का नीचे दिए अनुसार श्रेणी में क्षय होता है : 3

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

A_2 की द्रव्यमान संख्या और परमाणु संख्या क्रमशः 176 और 71 हैं । A_4 और A की द्रव्यमान और परमाणु संख्या निर्धारित कीजिए ।

(ii) β^+ और β^- क्षयों में होने वाली मूल नाभिकीय प्रक्रियाएँ लिखिए ।

(i) A radioactive nucleus 'A' undergoes a series of decays as given below :

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

The mass number and atomic number of A_2 are 176 and 71 respectively. Determine the mass and atomic numbers of A_4 and A.

(ii) Write the basic nuclear processes underlying β^+ and β^- decays.

16. किसी चल कुण्डली गैल्वेनोमीटर के कार्यकारी सिद्धान्त का वर्णन कीजिए । किसी गैल्वेनोमीटर में (i) अरीय चुम्बकीय क्षेत्र और (ii) बेलनाकार नरम लौह क्रोड का उपयोग करना आवश्यक क्यों है ? इस गैल्वेनोमीटर की धारा सुग्राह्यता के लिए व्यंजक लिखिए । 3

क्या किसी गैल्वेनोमीटर को इसी रूप में धारा की माप करने में उपयोग किया जा सकता है ? व्याख्या कीजिए ।

अथवा

(a) स्वप्रेरकत्व की परिभाषा और इसका S.I. मात्रक लिखिए ।

(b) दो परिनलिकाओं S_1 और S_2 के अन्योन्य प्रेरकत्व के लिए व्यंजक प्राप्त कीजिए । जबकि ये परिनलिकाएँ लम्बी एवं समाक्ष हैं, समान लम्बाई L की है, एक-दूसरे पर लिपटी हैं, त्रिज्याएँ r_1 और r_2 तथा प्रति एकांक लम्बाई फेरों की संख्या n_1 और n_2 है और बाहरी परिनालिका S_2 से धारा I प्रवाहित होती है ।

Describe the working principle of a moving coil galvanometer. Why is it necessary to use (i) a radial magnetic field and (ii) a cylindrical soft iron core in a galvanometer ? Write the expression for current sensitivity of the galvanometer.

Can a galvanometer as such be used for measuring the current ? Explain.

OR

(a) Define the term 'self-inductance' and write its S.I. unit.

(b) Obtain the expression for the mutual inductance of two long co-axial solenoids S_1 and S_2 wound one over the other, each of length L and radii r_1 and r_2 and n_1 and n_2 number of turns per unit length, when a current I is set up in the outer solenoid S_2.

17. किसी CE ट्रांजिस्टर प्रवर्धक में 2 kΩ के संग्राहक प्रतिरोध के सिरों पर श्रव्य सिगनल वोल्टता 2V है । दिया गया है कि इस ट्रांजिस्टर का धारा प्रवर्धन गुणांक 100 है । यदि आधार प्रतिरोध का मान 1 kΩ है तो निवेशी सिगनल वोल्टता और आधार धारा ज्ञात कीजिए । 3

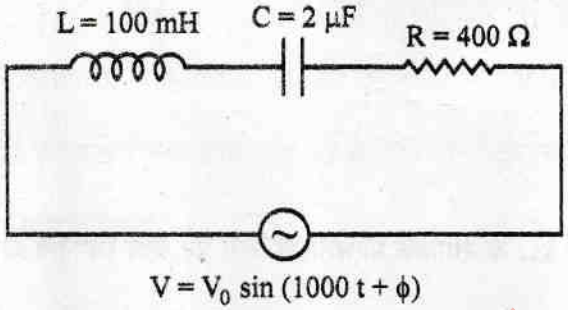
For a CE-transistor amplifier, the audio signal voltage across the collector resistance of 2 kΩ is 2V. Given the current amplification factor of the transistor is 100, find the input signal voltage and base current, if the base resistance is 1 kΩ.

18. किसी ज़ेनर डायोड का संविरचन संधि के p-और n-दोनों पार्श्वों को अधिक मादित करके किया जाता है । व्याख्या कीजिए कि ऐसा क्यों है ? परिपथ आरेख की सहायता से संक्षेप में व्याख्या कीजिए कि किसी ज़ेनर डायोड का dc वोल्टता नियंत्रक के रूप में उपयोग किस प्रकार किया जाता है । 3

A zener diode is fabricated by heavily doping both p- and n- sides of the junction. Explain, why ? Briefly explain the use of zener diode as a dc voltage regulator with the help of a circuit diagram.

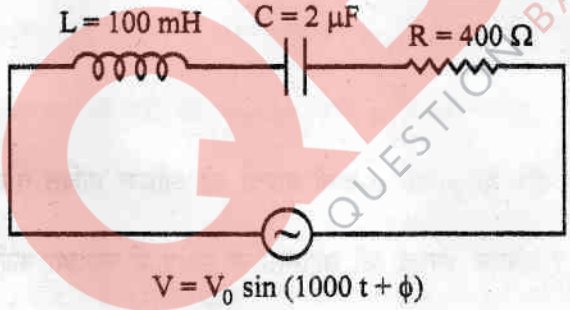
19. (i) नीचे दर्शाए गए श्रेणी LCR परिपथ में धारा और वोल्टता के बीच कलान्तर का मान ज्ञात कीजिए । धारा अथवा वोल्टता में कौन अग्रगामी है ? 3

(ii) अन्य कोई परिवर्तन किए बिना, संधारित्र C से पार्श्व में संयोजित किए जाने वाले उस अतिरिक्त संधारित्र C_1 का मान ज्ञात कीजिए । जिससे कि परिपथ का शक्ति गुणांक एकांक हो जाए ।



(i) Find the value of the phase difference between the current and the voltage in the series LCR circuit shown below. Which one leads in phase : current or voltage ?

(ii) Without making any other change, find the value of the additional capacitor C_1, to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity.



20. आयाम मॉडुलन की परिभाषा लिखिए । उन किन्हीं दो कारकों की व्याख्या कीजिए, जो किसी निम्न आवृत्ति आधार बैण्ड सिगनल के मॉडुलन की आवश्यकता की पुष्टि करते हैं । 3

Define the term 'amplitude modulation'. Explain any two factors which justify the need for modulating a low frequency base-band signal.

21. द्रव्यमान m_e का कोई इलेक्ट्रॉन +Ze आवेश के किसी नाभिक की परिक्रमा कर रहा है । दर्शाइए कि यह एक लघु चुम्बकीय द्विध्रुव की भाँति व्यवहार करता है । इस प्रकार सिद्ध कीजिए कि इससे संबद्ध चुम्बकीय आघूर्ण को $\vec{\mu} = -\frac{e}{2m_e}\vec{L}$ के रूप में व्यक्त किया जाता है, यहाँ $\vec{L}$ इलेक्ट्रॉन का कक्षीय कोणीय संवेग है । यहाँ पर ऋणात्मक चिह्न का महत्त्व लिखिए । 3

A electron of mass m_e revolves around a nucleus of charge + Ze. Show that it behaves like a tiny magnetic dipole. Hence prove that the magnetic moment associated with it is expressed as $\vec{\mu} = -\frac{e}{2m_e}\vec{L}$, where $\vec{L}$ is the orbital angular momentum of the electron. Give the significance of negative sign.

22. (i) किसी विद्युत द्विध्रुव की अक्षीय रेखा के किसी बिन्दु पर विद्युत विभव के लिए व्यंजक व्युत्पन्न कीजिए ।

(ii) किसी विद्युत द्विध्रुव के कारण समविभव पृष्ठों को चित्रित कीजिए । 3

(i) Derive the expression for the electric potential due to an electric dipole at a point on its axial line.

(ii) Depict the equipotential surfaces due to an electric dipole.

खण्ड – द

SECTION – D

23. श्रीमती रश्मि सिंह के चश्मे के लेंस टूट गए । जब वह दुकानदार के पास गयीं तो दुकानदार ने उन्हें काँच के लेंसों के स्थान पर प्लास्टिक के लेंसों का चश्मा बनवाने का सुझाव दिया । नया चश्मा प्राप्त करने पर उन्होंने यह पाया कि नये चश्मे के लेंस पहले वाले चश्मे की तुलना में मोटे हैं । उन्होंने इसके बारे में दुकानदार से प्रश्न किया परन्तु वह संतोषजनक उत्तर नहीं दे पाया । घर पहुँचने पर उन्होंने यही प्रश्न अपनी बेटी अनुजा से पूछा और उसने प्लास्टिक के लेंसों के मोटे होने की व्याख्या की ।

(a) अनुजा और उसकी माताजी प्रत्येक के द्वारा दर्शाए गए दो गुणों को लिखिए ।

(b) लेंस मेकर सूत्र द्वारा आप इस तथ्य की व्याख्या किस प्रकार करेंगे ? 4

Mrs. Rashmi Singh broke her reading glasses. When she went to the shopkeeper to order new spects, he suggested that she should get spectacles with plastic lenses instead of glass lenses. On getting the new spectacles, she found that the new ones were thicker than the earlier ones. She asked this question to the shopkeeper but he could not offer satisfactory explanation for this. At home, Mrs. Singh raised the same question to her daughter Anuja who explained why plastic lenses were thicker.

(a) Write two qualities displayed each by Anuja and her mother.

(b) How do you explain this fact using lens maker's formula ?

खण्ड – य
SECTION – E

24. (a) अध्रुवित प्रकाश और रैखिकत: ध्रुवित प्रकाश के बीच विभेदन कीजिए । किसी पोलेरॉयड की सहायता से रैखिकत: ध्रुवित प्रकाश किस प्रकार प्राप्त किया जाता है । **5**

(b) किसी पोलेरॉयड P_1 पर, तीव्रता I_0 का अध्रुवित प्रकाश का कोई पतला पुन्ज आपतन करता है । इस पोलेरॉयड द्वारा पारगमित प्रकाश फिर दूसरे पोलेरॉयड P_2 पर, जिसका पास-अक्ष P_1 के पास-अक्ष के सापेक्ष 60° का कोण बनाता है, आपतन करता है । P_2 से पारगमित प्रकाश की तीव्रता ज्ञात कीजिए ।

अथवा

(a) यंग के द्विझिरी प्रयोग के व्यतिकरण पैर्टन और एकल झिरी के कारण प्राप्त विवर्तन पैटर्न के बीच विभेदनकारी दो लक्षणों की व्याख्या कीजिए ।

(b) 500 nm तंरगदैर्ध्य का एकवर्णी प्रकाश 0.2 mm चौड़ाई की किसी एकल झिरी पर अभिलम्बवत् आपतन करके विवर्तन पैटर्न उत्पन्न करता है । पर्दे पर प्राप्त केन्द्रीय उच्चिष्ठ की कोणीय चौड़ाई ज्ञात कीजिए ।

एकल झिरी के कारण केन्द्रीय उच्चिष्ठ के कुल कोणीय प्रसार के क्षेत्र में समायोजित किए जा सकने वाले 05 mm चौड़ाई वाले फ्रिन्ज के यंग के द्विझिरी प्रयोग में प्राप्त फ्रिजों की संख्या का आकलन कीजिए ।

(a) Distinguish between unpolarized light and linearly polarized light. How does one get linearly polarised light with the help of a polaroid ?

(b) A narrow beam of unpolarised light of intensity I_0 is incident on a polaroid P_1. The light transmitted by it is then incident on a second polaroid P_2 with its pass axis making angle of 60° relative to the pass axis of P_1. Find the intensity of the light transmitted by P_2.

OR

(a) Explain two features to distinguish between the interference pattern in Young's double slit experiment with the diffraction pattern obtained due to a single slit.

(b) A monochromatic light of wavelength 500 nm is incident normally on a single slit of width 0.2 mm to produce a diffraction pattern. Find the angular width of the central maximum obtained on the screen.

Estimate the number of fringes obtained in Young's double slit experiment with fringe width 0.5 mm, which can be accommodated within the region of total angular spread of the central maximum due to single slit.

25. (i) किसी चालक में इलेक्ट्रॉनों के अपवाह वेग के लिए व्यंजक व्युत्पन्न कीजिए । इस प्रकार ओम के नियम की उत्पत्ति कीजिए । 5

(ii) कोई तार जिसकी अनुप्रस्थ-काट में एक सिरे से दूसरे सिरे तक रैखिकत: वृद्धि हो रही है किसी V वोल्ट की बैटरी से संयोजित है । तार में निम्नलिखित में से कौन सी राशियाँ नियत रहती है ?

(a) अपवाह वेग

(b) धारा घनत्व

(c) विद्युत धारा

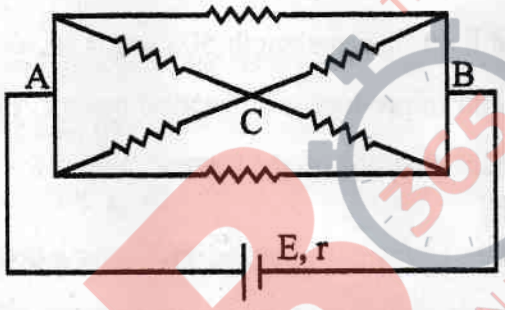
(d) विद्युत क्षेत्र

अपने उत्तरों की पुष्टि कीजिए ।

अथवा

(a) किरखोफ के दो नियम लिखिए । संक्षेप में व्याख्या कीजिए कि ये नियम किस प्रकार न्यायसंगत हैं ।

(b) चित्र में दर्शाए गए प्रतिरोधकों के नेटवर्क, जिसमें प्रत्येक प्रतिरोधक का प्रतिरोध r है, को उससे संयोजित आंतरिक प्रतिरोध r और emf E के किसी सेल द्वारा धारा प्रदान की गयी है । (i) सेल से ली गयी धारा और (ii) नेटवर्क में उपभुक्त शक्ति के लिए व्यंजक प्राप्त कीजिए ।



(i) Derive an expression for drift velocity of electrons in a conductor. Hence deduce Ohm's law.

(ii) A wire whose cross-sectional area is increasing linearly from its one end to the other, is connected across a battery of V volts. Which of the following quantities remain constant in the wire ?

(a) drift speed

(b) current density

(c) electric current

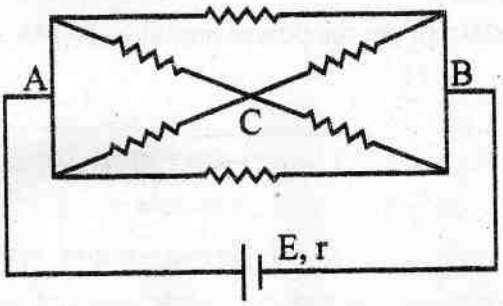
(d) electric field

Justify your answer.

OR

(i) State the two Kirchhoff's laws. Explain briefly how these rules are justified.

(ii) The current is drawn from a cell of emf E and internal resistance r connected to the network of resistors each of resistance r as shown in the figure. Obtain the expression for (i) the current draw from the cell and (ii) the power consumed in the network.



26. (a) किसी AC जनित्र का नामांकित आरेख खींचिए । कुण्डली में प्रेरित emf के तात्क्षणिक मान के लिए व्यंजक व्युत्पन्न कीजिए । **5**

(b) 3.0×10^{-2}T परिमाण के किसी एकसमान चुम्बकीय क्षेत्र में 20 फेरों और 200 cm^2 अनुप्रस्थ-काट की किसी वृत्ताकार कुण्डली को इसके ऊर्ध्वाधर व्यास के परित: 50 rad s^{-1} की कोणीय चाल से घूर्णित किया गया है । इस कुण्डली में अधिकतम धारा का मान परिकलित कीजिए ।

अथवा

(a) किसी उपचायी ट्रांसफॉर्मर का नामांकित आरेख खींचिए । दो कुण्डलियों में फेरों की संख्या और धाराओं के पदों में द्वितीयक और प्राथमिक वोल्टताओं का अनुपात प्राप्त कीजिए ।

(b) कोई शक्ति संचरण लाइन किसी अपचायी ट्रांसफॉर्मर को 2200 V पर निवेश शक्ति का भरण करती है । इस ट्रांसफॉर्मर की प्राथमिक कुण्डली में 3000 फेरे हैं । 220 V पर निर्गत शक्ति प्राप्त करने के लिए द्वितीयक कुण्डली में फेरों की संख्या ज्ञात कीजिए ।

(a) Draw a labelled diagram of AC generator. Derive the expression for the instantaneous value of the emf induced in the coil.

(b) A circular coil of cross-sectional area 200 cm^2 and 20 turns is rotated about the vertical diameter with angular speed of 50 rad s^{-1} in a uniform magnetic field of magnitude 3.0×10^{-2}T. Calculate the maximum value of the current in the coil.

OR

(a) Draw a labelled diagram of a step-up transformer. Obtain the ratio of secondary to primary voltage in terms of number of turns and currents in the two coils.

(b) A power transmission line feeds input power at 2200 V to a step-down transformer with its primary windings having 3000 turns. Find the number of turns in the secondary to get the power output at 220 V.

SET: DELHI 55/1/2

MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	SECTION B		
Q1	$B_H = B_E \cos\delta$ $B = B_E \cos 60^0 \Rightarrow B_E = 2B$ At equator $\delta = 0^0$ $\therefore B_H = 2B\cos 0 = 2B$ [Alternatively, Award full one mark, if student doesn't take the value (=2B)of B_E, while finding the value of horizontal component at equator, and just writes the formula only.]	½ ½	1
Q2	Solar cell	1	1
Q3	No, Because the charge resides only on the surface of the conductor.	½ ½	1
Q4	Speed of em waves is determined by the ratio of the peak values of electric and magnetic field vectors. [Alternatively, Give full credit, if student writes directly $C = \frac{E_o}{B_o}$]	1	1
Q5	No, As the magnetic field due to current carrying wire will be in the plane of the circular loop, so magnetic flux will remain zero. Alternatively [Magnetic flux does not change with the change of current.]	½ ½	1
Q6	Calculation of wavelength of electron in first excited state 2 Radius of nth orbit $r = r_o n^2 = 0.53n^2$ Å = 0.53 x 4 Å = 2.12 Å For an electron revolving in nth orbit, according to de Broglie relation $2\pi r_n = n\lambda$, For 1st excited state $n = 2$ $2 \times 3.14 \times 2.12 \times 10^{-10} = 2\lambda$ $\lambda = 3.14 \times 2.12 \times 10^{-10} n$ = 6.67 Å **Alternatively** $\lambda = \frac{h}{p} = \frac{h}{m_e v}$ velocity of electron in first excited state, $v = 1.1 \times 10^6$m/s $\lambda = \frac{6.63 \times 10^{-34}}{9 \times 10^{-31} \times 1.1 \times 10^6}$ $= 6.67 \times 10^{-10}$m = 6.67Å Alternatively	½ ½ ½ ½ ½ ½ ½ ½	2 2

	Let λ_n be the wavelength of the electron in the n[th] orbit. We then have $2\pi r_n = n\lambda_n$ $\therefore \lambda_2 = \pi r_2$ Also $r_2 = 4r_0$ (r_0 = radius of the ground state orbit) $\therefore \lambda_2 = 4\pi r_0$ Alternatively, Let λ_n be the wavelength of the electron in the n[th] orbit. We then have $\lambda_n = \frac{h}{mv_n}$ But $v_n = \frac{v_0}{n}$ $\therefore \lambda_2 = \frac{2\,h}{mv_0}$ where $v_0$is the velocity of electron in ground state.	1 ½ ½ 1 ½ ½	2 2
Q7	Distinction between transducer and repeater 2 **Transducer** : A device which converts one form of energy into another. **Repeater** : A combination of receiver and transmitter / It picks signals from a transmitter; amplifies and retransmits them.	1 1	2
Q8	Explanation of flow of current through capacitor 1 Expression for displacement current 1 During charging, electric flux between the plates of capacitor keeps on changing; this results in the production of a displacement current between the plates. $I_d = \epsilon_o \frac{d\varphi_E}{dt}$ ($/ I_d = \epsilon_o A \frac{dE}{dt}$)	1 1	2

Q9

Definition of distance of closest approach	1
Finding of distance of closest approach when Kinetic energy is doubled	1

It is the distance of charged particle from the centre of the nucleus, at which the whole of the initial kinetic energy of the (far off) charged particle gets converted into the electric potential energy of the system. 1

Distance of closest approach (r_c) is given by

$$r_c = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2Ze^2}{K}$$ ½

'K' is doubled, $\therefore$ r_c becomes $\frac{r}{2}$ ½

[Alternatively: If a candidate writes directly $\frac{r}{2}$ without mentioning formula, award the 1 mark for this part.] 2

OR

Two important limitations of Rutherford nuclear model	1+1

1. According to Rutherford model, electron orbiting around the nucleus, continuously radiates energy due to the acceleration; hence the atom will not remain stable. 1
2. As electron spirals inwards; its angular velocity and frequency change continuously; therefore it will emit a continuous spectrum. 1 2

Q10

Reasons for having large focal length and large aperture of objective of telescope and their justification	1+1

Large focal length : to increase magnifying power ½

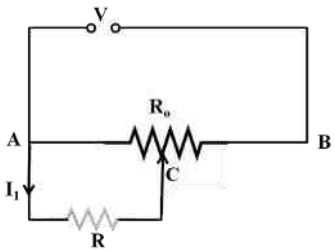
$\left(\because m = \frac{f_o}{f_e}\right)$ ½

Large aperature : to increase resolving power. ½

$\left(\because \text{RP} = \frac{2a}{1.22\lambda}\right)$ ½ 2

Q11

Derivation of expression of voltage across resistance R	3



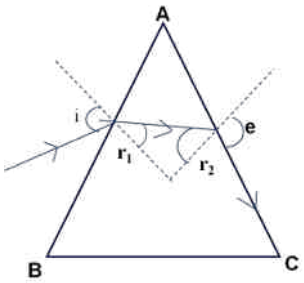
Resistance between points A & C

$\frac{1}{R_1} = \frac{1}{R} + \frac{1}{\left(\frac{R_0}{2}\right)}$ ½

Effective resistance between points A & B

	$R_2 = \left(\frac{R\,\frac{R_o}{2}}{R+\frac{R_o}{2}}\right)+\frac{R_o}{2}$ Current drawn from the voltage source, $I = \frac{V}{R_2}$ $I = \frac{V}{\left(\frac{R\,\frac{R_o}{2}}{R+\frac{R_o}{2}}\right)+\frac{R_o}{2}}$ Let current through R be I_1 $I_1 = \frac{I\left(\frac{R_o}{2}\right)}{R+\frac{R_o}{2}}$ Voltage across R $V_I = I_I\,R$ $= \frac{IR_o}{2\left(R+\frac{R_o}{2}\right)}.R$ $= \frac{R\,R_o}{2\left(R+\frac{R_o}{2}\right)}\cdot\frac{V}{\left(\frac{R\,R_o}{2R+R_o}\right)+\frac{R_o}{2}}$ $= \frac{2RV}{R_o+4R}$	½ ½ ½ ½ ½	3
Q12	Identification of metal which has higher threshold frequency ½ Determination of the work function of the metal which has greater value 1½ Calculation of maximum kinetic energy (K_{max}) of electron emitted by light of frequency $8\times10^{14}\ Hz$ 1 i) Q has higher threshold frequency ii) Work function $\phi_o = hv_o$ $hv_o = (6.6\times10^{-34})\times\frac{6\times10^{-14}}{1.6\times10^{-19}}eV$ $= 2.5eV$ $K_{max} = h(v-v_o)$ $= \frac{6.6\times10^{-34}\times2\times10^{14}}{1.6\times10^{-19}}eV$ $K_{max} = 0.83eV$	½ ½ ½ ½ ½	3
Q13	Calculation of electrostatic energy in 12 pF capacitor 1 Total charge stored in combination 1 Potential difference across each capacitor ½ + ½ Energy stored, in the capacitor of capacitance 12 pF,		

	$U = \frac{1}{2} CV^2$ $= \frac{1}{2} \times 12 \times 10^{-12} \times 50 \times 50$ J $= 1.5 \times 10^{-8}$ J C= Equivalent capacitance of 12 pF and 6 pF, in series, is given by $\frac{1}{C} = \frac{1}{12} + \frac{1}{6} = \frac{1+2}{12}$ ∴ C = 4 pF ∴ Charge stored across each capacitor $q = C V$ $= 4 \times 10^{-12} \times 50$ C $= 2 \times 10^{-10}$ C Charge on each capacitor 12 pF as well as 6 pF ∴ Potential difference across capacitor C_1 $\therefore V_1 = \frac{2 \times 10^{-10}}{12 \times 10^{-12}}$ volt $= \frac{50}{3}$ V Potential difference across capacitor C_2 $V_2 = \frac{2 \times 10^{-10}}{6 \times 10^{-12}}$ volt $= \frac{100}{3}$ V	½ ½ ½ ½ ½ ½	3
Q14	i. Calculation of speed of light 1 ½ ii. Calculation of angle of incidence at face AB 1 ½ **i.** $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ $= \frac{\sin\left(\frac{60+30}{2}\right)}{\sin\left(\frac{60^0}{2}\right)} = \sqrt{2}$ Also $\mu = \frac{c}{v} \Longrightarrow v = \frac{3\times10^8}{\sqrt{2}}$m/s $= 2.122 \times 10^8 m/s$	½ ½ ½	

	ii.  At face AC, let the angle of incidence be r_2. For grazing ray, e = 90^o $\Rightarrow \mu = \frac{1}{sinr_2} \Rightarrow r_2 = sin^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45^o$ Let angle of refraction at face AB be r_1. Now $r_1 + r_2 = A$ $\therefore r_1 = A - r_2 = 60^o - 45^o = 15^o$ Let angle of incidence at this face be i $\mu = \frac{\sin i}{sinr_1}$ $\Rightarrow \sqrt{2} = \frac{\sin i}{sin15^o}$ $\therefore i = sin^{-1}(\sqrt{2}.\sin 15^o)$	½ ½ ½	3
Q15	i. Determining the mass and atomic number of A_4 and A ½ x 4 ii. Basic nuclear processes of β^+ and β^- decays ½ + ½ **i.** A_4 : Mass Number : 172 Atomic Number : 69 ii. A : Mass Number :180 Atomic Number : 72 [Alternatively **:** Give full credit if student considers β^+ decay and find atomic and mass numbers accordingly $^{180}_{72}A \xrightarrow{\alpha} {}^{176}_{70}A_1 \xrightarrow{\beta^-} {}^{176}_{71}A_2 \xrightarrow{\alpha} {}^{172}_{69}A_3 \xrightarrow{r} {}^{172}_{69}A_4$ Gives the values quoted above. If the student takes β^+ decay $^{180}_{74}A \xrightarrow{\alpha} {}^{176}_{72}A_1 \xrightarrow{\beta^+} {}^{176}_{71}A_2 \xrightarrow{\alpha} {}^{172}_{69}A_3 \xrightarrow{r} {}^{172}_{69}A_4$ This would give the answers: (A_4:172,69);(A:180,74)] Basic nuclear process for β^+ decay $p \rightarrow n + {}^0_1e + v$ For β^-decay $n \rightarrow p + {}^0_{-1}e + \bar{v}$ **[Note:** Give full credit of this part, if student writes the processes as conversion of proton into neutron for β^+decay and neutron into proton for β^-decay.]	½ ½ ½ ½ ½ ½	3

Q16

Working Principle of moving coil galvanometer	1
Necessity of (i) radial magnetic field	½
(ii) cylindrical soft iron core	½
Expression for current sensitivity	½
Explanation of use of Galvanometer to measure current	½

When a coil, carrying current, and free to rotate about a fixed axis, is placed in a uniform magnetic field, it experiences a torque (which is balanced by a restoring torque of suspension). — 1

(i) To have deflection proportional to current / to maximize the deflecting torque acting on the current carrying coil. — ½

(ii) To make magnetic field radial / to increase the strength of magnetic field. — ½

Expression for current sensitivity

$I_s = \frac{\theta}{I}$ *or* $\frac{NAB}{K}$ — ½

where θ is the deflection of the coil

No — ½

The galvanometer, can only detect currents but cannot measure them as it is not calibrated. The galvanometer coil is likely to be damaged by currents in the (mA/A) range] — 3

OR

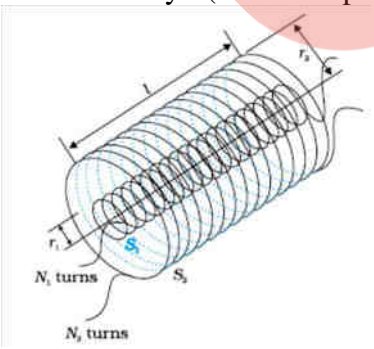
a) Definition of self inductance and its SI unit	1 + ½
b) Derivation of expression for mutual inductance	1 ½

Self inductance of a coil equals, the magnitude of the magnetic flux, linked with it, when a unit current flows through it. — 1

Alternatively

Self inductance, of a coil, equals the magnitude of the emf induced in it, when the current in the coil, is changing at a unit rate.

SI unit : henry / (weber/ampere) / (ohm second.) — ½



½

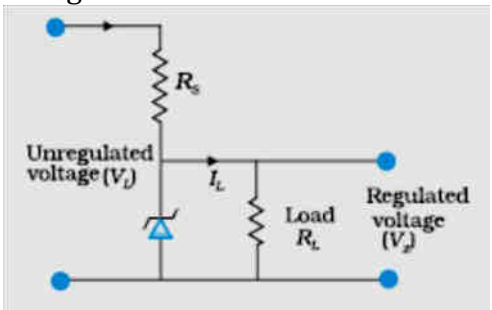
When current I_2 is passed through coil S_2, it in turn sets up a magnetic flux through S_1: $\Phi_1 = (n_1\ell)(\pi r_1^2)(B_2)$ — ½

$\Phi_1 = (n_1\ell)(\pi r_1^2)(\mu_o n_2 I_2)$

$\Phi_1 = \mu_o n_1 n_2 I_2 \pi r_1^2 \ell I_2$

But $\Phi_1 = M_{12} I_2$

$\Rightarrow M_{12} = \mu_o n_1 n_2 \pi r_1^2 \ell$ — ½

	[Note : If the student derives the correct expression, without giving the diagram of two coaxial coils, full credit can be given]		3
Q17	Calculation of collector current I_c, base current I_B and input signal voltage V_i 1+1+1 Given R_c =2kΩ = 2 x $10^3\Omega$ $V_{CE} = I_c R_c$ $I_c = \frac{V_{CE}}{R_c} = \frac{2}{2 \times 10^3} A$ $= 10^{-3} A$ $= 1mA$ current gain $\beta = \frac{I_c}{I_B}$ $\therefore 100 = \frac{10^{-3}}{I_B}$ $\therefore I_B = 10^{-5} A$ Input signal voltage $V_i = I_B R_B$ = 1 x $10^{-5} \times 10^3\Omega$ =$10^{-2} V$ [**Note** : Give full credit if student calculates the required quantities by any other alternative method]	½ ½ ½ ½ ½ ½	3
Q18	Explanation of heavily doping of both p and n sides of Zener diode 1 Circuit diagram of Zener diode as a dc voltage regulator 1 Explanation of the use of Zener diode as a dc voltage regulator. 1 By heavily doping both p and n sides of the junction, depletion region formed is very thin, i.e. < 10^{-6} m. Hence, electric field, across the junction is very high $(\sim 5 \times 10^6 \mathrm{V/m})$ even for a small reverse bias voltage. This can lead to a 'breakdown' during reverse biasing.  If the input voltage increases/decreases, current through resister R_s , and Zener diode, also increases/decreases. This increases/decreases the voltage drop across R_s without any change in voltage across the Zener diode. This is because, in the breakdown region, Zener voltage remains constant even though the current through the Zener diode changes.	1 1 1	3

Q19

(i) Calculation of phase difference between current and voltage	1
Name of quantity which leads	½
(ii) Calculation of value of 'C', is to be connected in parallel	1 ½

i. $X_L = \omega L = (1000 \times 100 \times 10^{-3})\Omega = 100\Omega$

$X_C = \frac{1}{\omega C} = \left(\frac{1}{1000 \times 2 \times 10^{-6}}\right)\Omega = 500\Omega$ ½

Phase angle

$\tan \Phi = \frac{X_L - X_C}{R}$

$\tan \Phi = \frac{100-500}{400} = -1$

$\Phi = -\frac{\pi}{4}$ ½

As $X_C > X_L$, (/phase angle is negative), hence current leads voltage ½

ii. To make power factor unity

$X_{C'} = X_L$ ½

$\frac{1}{WC'} = 100$

$C' = 10\mu F$ ½

$C' = C + C_1$

$10 = 2 + C_1$

$C_1 = 8\mu F$ ½ 3

Q20

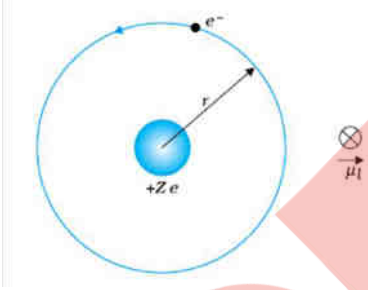
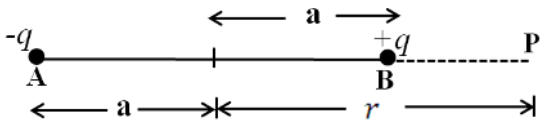
Definition of amplitude modulation	1
Explanation of two factors justifying the need of modulation	2

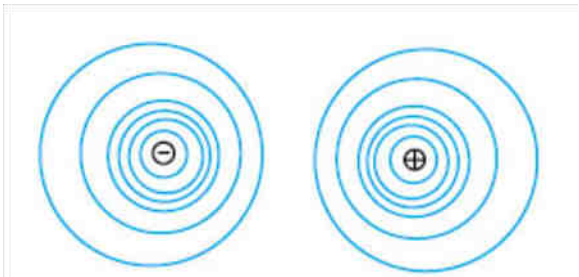
It is the process of superposition of information/message signal over a carrier wave in such a way that the amplitude of carrier wave is varied according to the information signal/message signal. 1

Direct transmission, of the low frequency base band information signal, is not possible due to the following reasons;

(i) Size of Antenna: For transmitting a signal, minimum height of antenna should be $\frac{\lambda}{4}$; with the help of modulation wavelength of signal decreases, hence height of antenna becomes manageable. 1

(ii) Effective power radiated by an antenna:
Effective power radiated by an antenna varies inversely as λ^2, hence effective power radiated into the space, by the antenna, ½ + ½

	increases. (iii)To avoid mixing up of signals from different transmitters. (Any two)		3
Q21	i. Behaviour of revolving electron as a tiny magnetic dipole 1 ii. Proof of the relation $\vec{\mu} = -\frac{e}{2m_e}\vec{L}$ 1 ½ iii. Significance of negative sign ½ Electron, in circular motion around the nucleus, constitutes a current loop which behaves like a magnetic dipole. Current associated with the revolving electron: $I = \frac{e}{T}$ and $T = \frac{2\pi r}{v}$ $\therefore I = \frac{e}{2\pi r} v$  Magnetic moment of the loop, $\mu = IA$ $\mu = IA = \frac{ev}{2\pi r}\pi r^2 = \frac{evr}{2} = \frac{e.m_e vr}{2m_e}$ Orbital angular momentum of the electron, $L = m_e vr$ $\vec{\mu} = \frac{-e}{2m_e}\vec{L}$ -ve sign signifies that the angular momentum of the revolving electron is opposite in direction to the magnetic moment associated with it.	1 ½ ½ ½ ½	3
Q22	(i) Derivation of expression for the electric potential due to an electric dipole at a point on the axial line 2 (ii) Depiction of equipotential surfaces due to an electric dipole 1 Potential due to charge at A, $V_A = \frac{1}{4\pi\epsilon_0}\frac{-q}{(r+a)}$ Potential due to charge at B , $V_B = \frac{1}{4\pi\epsilon_0}\frac{+q}{(r-a)}$  $\therefore$ Potential at point P, $V = V_B + V_A$	½ ½ ½	

	$\therefore$ Net Potential at P $= \frac{q}{4\pi\epsilon_0}\left[\frac{-1}{(r+a)}+\frac{1}{(r-a)}\right]$ $V=\frac{q\times 2a}{4\pi\epsilon_0(r^2-a^2)}$ [**Note** : Also accept any other alternative correct method.] 	½ 1	3
Q23	a) Two qualities each of Anuja and her mother ½ x 4 b) Explanation, using lens maker's formula 2 a) Anuja : Scientific temperament, co-operative, knowledgeable (any two) Mother : Inquisitive, scientific temper/keen to learn/has no airs(any two)(or any other two similar values) b) $\frac{1}{f}=\left(\frac{\mu_2}{\mu_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ As the refractive index of plastic material is less than that of glass material therefore, for the same power ($= {}^{1}/_{f}$), the radius of currature of plastic material is small. Therefore plastic lens is thicker. Alternatively, If student just writes that plastic has a different refractive index than glass, award one mark for this part.	½+ ½ ½ + ½ ½ ½ ½ ½	4
Q24	a) Distinction between unpolarised and linearly polarized light 2 Obtaining linearly polarized Light 1 b) Calculation of intensely of light 2 a) In an unpolarized light, the oscillations, of the electric field, are in random directions, in planes perpendicular to the direction of propagation. For a polarized light, the oscillations are aligned along one particular direction. Alternatively Polarized light can be distinguished, from unpolarized light, when it is allowed to pass through a polaroid. Polarized light does can show change in its intensity, on passing through a Polaroid; intensity remains same in case of unpolarized light.	1 1 1	

When unpolarised light wave is incident on a polaroid, then the electric vectors along the direction of its aligned molecules, get absorbed; the electric vector, oscillating along a direction perpendicular to the aligned molecules, pass through. This light is called linearly polarized light. — 1

b) According to Malus' Law: — ½

$I = I_o \cos^2\theta$

$\therefore I = (\frac{I_o}{2}) \cos^2\theta$, where I_o is the intensity of unpolarized light.

$\theta = 60^o$ (given)

$I = \frac{I_o}{2} \cos^2 60^o = \frac{I_o}{2} \times \left(\frac{1}{2}\right)^2$ — ½

$= \frac{I_o}{8}$ — 5

OR

a) Explanation of two features (distinguishing between interference pattern and diffraction pattern.)	2
b) Calculation of angular width of central maxima	2
Estimation of number of fringes	1

a)

Interference Pattern	Diffraction pattern
1) All fringes are of equal width.	1) Width of central maxima is twice the width of higher order bands.
2) Intensity of all bright bands is equal.	2) Intensity goes on decreasing for higher order of diffraction bands.

1+1

[Note: Also accept any other two correct distinguishing features.]

b) Angular width of central maximum

$\omega = \frac{2\lambda}{a}$ — ½

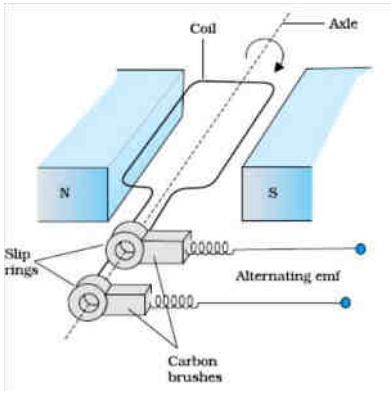
$= \frac{2\times500\times10^{-9}}{0.2\times10^{-3}}$ radian — ½

$= 5 \times 10^{-3}$ radian — 1

$\beta = \frac{\lambda D}{d}$

Linear width of central maxima in the diffraction pattern

	$\omega' = \frac{2\lambda D}{a}$ Let 'n' be the number of interference fringes which can be accommodated in the central maxima $\therefore n \times \beta = \omega'$ $n = \frac{2\lambda D}{a} \times \frac{d}{\lambda D}$ $n = \frac{2d}{a}$ [Award the last ½ mark if the student writes the answers as 2 (taking $d=a$), or just attempts to do these calculation.]	½ ½	5
Q25	i. Derivation of the expression for drift velocity 2 Deduction of Ohm's law 2 ii. Name of quantity and justification ½ + ½ Let an electric field E be applied the conductor. Acceleration of each electron is $a = -\frac{eE}{m}$ Velocity gained by the electron $v = -\frac{eE}{m}t$ Let the conductor contain n electrons per unit volume. The average value of time $'t'$, between their successive collisions, is the relaxation time, $'\tau'$. Hence average drift velocity $v_d = \frac{-eE}{m}\tau$ The amount of charge, crossing area A, in time Δt,is $\equiv neAv_d\Delta t = I\Delta t$ Substituting the value of v_d, we get $I\Delta t = neA\left(\frac{eE\tau}{m}\right)\Delta t$ $\therefore I = \left(\frac{e^2A\tau n}{m}\right)E = \sigma E, \left(\sigma = \frac{e^2\tau n}{m} \text{ is the conductivity}\right)$ But I = JA, where J is the current density $\Rightarrow J = \left(\frac{e^2\tau n}{m}\right)E$ $\Rightarrow J = \sigma E$ This is Ohm's law [Note : Credit should be given if the student derives the alternative form of Ohm's law by substituting $E = \frac{V}{\ell}$] ii) Electric current well remain constant in the wire. All other quantities, depend on the cross sectional area of the wire. **OR**	½ ½ ½ ½ ½ ½ ½ ½	5

	(i) Statement of Kirchoff's laws 1+1 Justification ½ + ½ (ii) Calculation of i) current drawn and 1 ii) Power consumed 1		
	(i) Junction Rule: At any Junction, the sum of currents, entering the junction, is equal to the sum of currents leaving the junction. Loop Rule: The Algebraic sum, of changes in potential, around any closed loop involving resistors and cells, in the loop is zero. $\sum(\Delta V) = 0$ Justification: The first law is in accord with the law of conservation of charge. The Second law is in accord with the law of conservation of energy. ii) Equivalent resistance of the loop $R = {}^{r}/_{3}$ Hence current drawn from the cell $I = \frac{E}{{}^{r}/_{3}+r} = \frac{3E}{4r}$ Power consumed $P = I^2\ ({}^{r}/_{3})$ $= \frac{9E^2}{16r^2} \times {}^{4r}/_{3} = \frac{3E^2}{4r}$ [Note: Award the last 1 ½ marks for this part, if the calculations, for these parts, are done by using (any other) value of equivalent resistance obtained by the student.)	1 1 ½ ½ ½ ½ ½ ½	5
Q26	a) Labelled diagram of AC generator 1 ½ Expression for instantaneous value of induced emf. 1 ½ b) Calculation of maximum value of current 2  	1 ½	

[Deduct ½ mark, If diagram is not labeled]

When the coil is rotated with constant angular speed ω, the angle θ between the magnetic field and area vector of the coil, at instant t, is given by $\theta = \omega t$,

Therefore, magnets flux, (ϕ_B), at this instant, is

ϕ_B = BA cos ω t ½

∴Induced emf $e = -N\frac{d\phi_B}{dt}$ ½

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

$e = e_o \sin \omega t$

where e_o= NBA ω ½

b) Maximum value of emf

e_o= NBA ω ½

$= 20 \times 200 \times 10^{-4} \times 3 \times 10^{-2} \times 50V$ ½

= 600 mV ½

Maximum induced current $i_o = \frac{e_o}{R} = \frac{600}{R}$mA ½

[Note 1: It the student calculates the value of the maximum induced emf and says that " since R is not given, the value of maximum induced current cannot be calculated", the ½ mark, for the last part, of the question, can be given.]

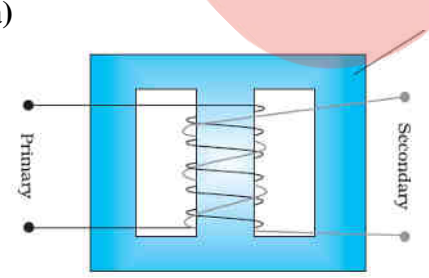
[Note 2: The direction of magnetic field has not been given. If the student takes this direction along the axis of rotation and hence obtains the value of induced emf and, therefore, maximum current, as zero, award full marks for this part.]

5

OR

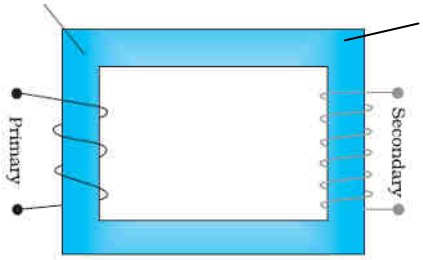
a)	Labelled diagram of a step up transformer	1 ½
	Derivation of ratio of secondary and primary voltage	2
b)	Calculation of number of turns in the secondary	1 ½

a)



1 ½

Alternatively



	[Note: Deduct ½ mark, if labeling is not done] a) When ac voltage is applied to primary coil the resulting current produces an alternating magnetic flux, which also links the secondary coil. The induced emf, in the secondary coil, having N_s turns, is $e_s = -N_s \frac{d\varphi}{dt}$ This flux, also induces an emf, called back emf, in the primary coil. $e_p = -N_p \frac{d\varphi}{dt}$ But $e_p = V_p$ and $e_s = V_s$ $\Rightarrow \frac{V_s}{V_p} = \frac{N_s}{N_p}$ For an ideal transformer $l_p \; V_p = \; i_s \; V_s$ $\Rightarrow \frac{V_s}{V_p} = \frac{i_p}{i_s}$ b) $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ $\frac{N_s}{3000} = \frac{220}{2200}$ $\therefore N_s = 300$	½ ½ ½ ½ ½ ½ ½	5