Set-2

Series RQSP4/4

प्रश्न-पत्र कोड
Q.P. Code **55/4/2**

रोल नं.
Roll No.

परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।
Candidates must write the Q.P. Code on the title page of the answer-book.

भौतिक विज्ञान (सैद्धान्तिक)
PHYSICS (Theory)

निर्धारित समय : 3 घण्टे | *अधिकतम अंक : 70*
Time allowed : 3 hours | *Maximum Marks : 70*

नोट	NOTE
(I) कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **23** हैं ।	(I) Please check that this question paper contains **23** printed pages.
(II) कृपया जाँच कर लें कि इस प्रश्न-पत्र में **33** प्रश्न हैं ।	(II) Please check that this question paper contains **33** questions.
(III) प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।	(III) Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
(IV) **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें ।**	(IV) **Please write down the serial number of the question in the answer-book before attempting it.**
(V) 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 परीक्षार्थी केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।	(V) 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 candidates will read the question paper only and will not write any answer on the answer-book during this period.

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सामान्य निर्देश :

निम्नलिखित निर्देशों को बहुत सावधानी से पढ़िए और उनका पालन कीजिए :

(i) *इस प्रश्न-पत्र में 33 प्रश्न हैं।* ***सभी प्रश्न अनिवार्य हैं।***

(ii) *प्रश्न-पत्र* ***पाँच*** *खण्डों में विभाजित है – खण्ड-**क, ख, ग, घ** तथा **ङ**।*

(iii) ***खण्ड – क –*** *प्रश्न संख्या 1 से 16 तक बहुविकल्पीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न 1 अंक का है।*

(iv) ***खण्ड – ख –*** *प्रश्न संख्या 17 से 21 तक अति लघु-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न 2 अंकों का है।*

(v) ***खण्ड – ग –*** *प्रश्न संख्या 22 से 28 तक लघु-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न 3 अंकों का है।*

(vi) ***खण्ड – घ –*** *प्रश्न संख्या 29 एवं 30 केस अध्ययन आधारित प्रश्न हैं। प्रत्येक प्रश्न 4 अंकों का है।*

(vii) ***खण्ड – ङ –*** *प्रश्न संख्या 31 से 33 तक दीर्घ-उत्तरीय प्रकार के प्रश्न हैं। प्रत्येक प्रश्न 5 अंकों का है।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है। यद्यपि, खण्ड-**क** के अतिरिक्त अन्य खण्डों के कुछ प्रश्नों में आंतरिक विकल्प का चयन दिया गया है।*

(ix) *ध्यान दें कि* ***दृष्टिबाधित परीक्षार्थियों*** *के लिए एक अलग प्रश्न-पत्र है।*

(x) *कैल्कुलेटर का उपयोग वर्जित है।*

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

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

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General Instructions :

Read the following instructions very carefully and follow them :

(i) *This question paper contains* ***33*** *questions.* ***All questions are compulsory.***

(ii) *Question paper is divided into* ***FIVE*** *sections – Section* ***A****,* ***B****,* ***C****,* ***D*** *and* ***E****.*

(iii) ***Section A –*** *Question number* ***1*** *to* ***16*** *are Multiple Choice (MCQ) type questions. Each question carries* ***1*** *mark.*

(iv) ***Section B –*** *Question number* ***17*** *to* ***21*** *are Very Short Answer type questions. Each question carries* ***2*** *mark.*

(v) ***Section C –*** *Question number* ***22*** *to* ***28*** *are Short Answer type questions. Each question carries* ***3*** *mark.*

(vi) ***Section D :*** *Question number* ***29*** *and* ***30*** *are Case-Based questions. Each question carries* ***4*** *mark.*

(vii) ***Section E –*** *Question number* ***31*** *to* ***33*** *are Long Answer type questions. Each question carries* ***5*** *mark.*

(viii) *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section–****A****.*

(ix) *Kindly note that there is a separate question paper for Visually Impaired candidates.*

(x) *Use of calculators is NOT allowed.*

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 – क

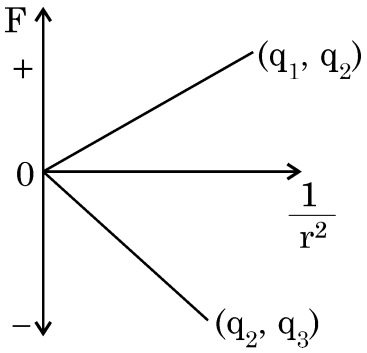
$16 \times 1 = 16$

1. किसी त्रिभुज ABC जिसकी भुजा AB = AC = 5L तथा भुजा BC = 6L है, के शीर्षों पर तीन बिन्दु आवेश जिनमें प्रत्येक का आवेश q है, स्थित हैं । भुजा BC के मध्य बिंदु पर स्थिर विद्युत विभव होगा । **1**

(A) $\frac{11}{48}\frac{q}{\pi\varepsilon_0 L}$ (B) $\frac{8q}{36\pi\varepsilon_0 L}$

(C) $\frac{5q}{24\pi\varepsilon_0 L}$ (D) $\frac{1}{16}\frac{q}{\pi\varepsilon_0 L}$

2. आवेशों के दो युगलों (q_1 और q_2) तथा (q_2 और q_3) के लिए कूलॉम बल (F) और ($1/r^2$) के बीच ग्राफ आरेख में दर्शाए अनुसार हैं । आवेश q_2 धनात्मक है तथा इसका परिमाण अल्पतम है । तब **1**



(A) $q_1 > q_2 > q_3$ (B) $q_1 > q_3 > q_2$

(C) $q_3 > q_2 > q_1$ (D) $q_3 > q_1 > q_2$

3. किसी प्रतिचुम्बकीय पदार्थ की चुम्बकीय प्रवृत्ति होती है **1**

(A) कम और ऋणात्मक (B) कम और धनात्मक

(C) अधिक और ऋणात्मक (D) अधिक और धनात्मक

4. त्रिज्या R के किसी वृत्ताकार पाश A से कोई धारा I प्रवाहित हो रही है । त्रिज्या $r\left(=\frac{R}{20}\right)$ के किसी वृत्ताकार पाश B को A के तल में संकेन्द्री रखा गया है । पाश B से संबद्ध चुम्बकीय फ्लक्स निम्नलिखित में किसके अनुक्रमानुपाती है ? **1**

(A) R (B) $\sqrt{R}$

(C) $R^{\frac{3}{2}}$ (D) R^2

5. द्रव्यमान m तथा आवेश q का कोई कण किसी वेग $\vec{v} = v_x \hat{i} + v_y \hat{j}$ से गतिमान है । यदि इस कण पर कोई चुम्बकीय क्षेत्र $\vec{B} = B_0 \hat{i}$ आरोपित किया जाए तो यह कण गति करेगा **1**

(A) सरल रेखीय पथ पर (B) वृत्ताकार पथ पर

(C) कुण्डलिनी पथ पर (D) परवलीय पथ पर

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SECTION – A

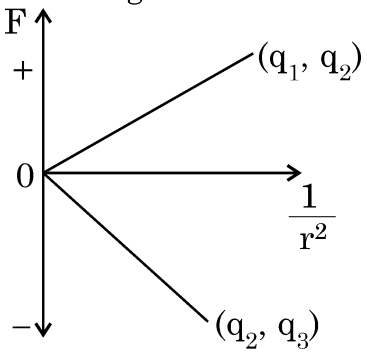
16 × 1 = 16

1. Three point charges, each of charge q are placed on vertices of a triangle ABC, with AB = AC = 5L, BC = 6L. The electrostatic potential at midpoint of side BC will be **1**

(A) $\frac{11}{48}\frac{q}{\pi\varepsilon_0 L}$ (B) $\frac{8q}{36\pi\varepsilon_0 L}$

(C) $\frac{5q}{24\pi\varepsilon_0 L}$ (D) $\frac{1}{16}\frac{q}{\pi\varepsilon_0 L}$

2. The Coulomb force (F) versus $(1/r^2)$ graphs for two pairs of point charges (q_1 and q_2) and (q_2 and q_3) are shown in figure. The charge q_2 is positive and has least magnitude. Then **1**



(A) $q_1 > q_2 > q_3$ (B) $q_1 > q_3 > q_2$

(C) $q_3 > q_2 > q_1$ (D) $q_3 > q_1 > q_2$

3. The magnetic susceptibility for a diamagnetic material is **1**

(A) small and negative (B) small and positive

(C) large and negative (D) large and positive

4. A circular loop A of radius R carries a current I. Another circular loop B of radius $r\left(=\frac{R}{20}\right)$ is placed concentrically in the plane of A. The magnetic flux linked with loop B is proportional to **1**

(A) R (B) $\sqrt{R}$

(C) $R^{\frac{3}{2}}$ (D) R^2

5. A particle of mass m and charge q is moving with velocity $\vec{v} = v_x\hat{i} + v_y\hat{j}$. If it is subjected to a magnetic field $\vec{B} = B_0\hat{i}$, it will move in a – **1**

(A) straight line path (B) circular path

(C) helical path (D) parabolic path

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6. प्रकाश की क्वान्टम प्रकृति प्रकाशविद्युत प्रभाव की व्याख्या इस प्रकार करती है – 1

(A) आपतित विकिरणों की कोई निम्नतम आवृत्ति होती है जिससे कम पर कोई इलेक्ट्रॉन उत्सर्जित नहीं होते ।

(B) फोटो-इलेक्ट्रॉनों की अधिकतम गतिज ऊर्जा केवल आपतित विकिरणों की आवृत्ति पर निर्भर करती है ।

(C) जब धातु-पृष्ठ को प्रदीप्त किया जाता है तो कुछ समय पश्चात् पृष्ठ से इलेक्ट्रॉन उत्सर्जित होते हैं ।

(D) प्रकाश विद्युत धारा आपतित विकिरणों की तीव्रता पर निर्भर नहीं करती है ।

7. z-अक्ष के अनुदिश संचरण करती किसी विद्युत चुम्बकीय तरंग के विद्युत क्षेत्र $\vec{E}$ और चुम्बकीय क्षेत्र $\vec{B}$ के बीच कलान्तर होता है – 1

(A) शून्य (B) π

(C) $\frac{\pi}{2}$ (D) $\frac{\pi}{4}$

8. हाइड्रोजन परमाणु के बोर-मॉडल में nवीं कक्षा की त्रिज्या (r_n) n के साथ किस प्रकार विचरण करती है ? 1

(A) $r_n \propto n$ (B) $r_n \propto \frac{1}{n}$

(C) $r_n \propto n^2$ (D) $r_n \propto \frac{1}{n^2}$

9. 1 μF धारिता के किसी संधारित्र के सिरों से किसी ac स्रोत $V = 282 \sin (100\ t)$ वोल्ट को संयोजित किया गया है । इस परिपथ में धारा का rms मान होगा ($\sqrt{2} = 1.41$ लीजिए) 1

(A) 10 mA (B) 20 mA

(C) 40 mA (D) 80 mA

10. किसी गैल्वैनोमीटर को जिसका प्रतिरोध 100 Ω है, 0.1 Ω के प्रतिरोध का उपयोग करके (0 – 1 A) परिसर के एमीटर में परिवर्तित किया गया है । यह जिस धारा के लिए पूर्ण पैमाना विक्षेपण दर्शाएगा, वह धारा है लगभग 1

(A) 0.1 mA (B) 1 mA

(C) 10 mA (D) 0.1 A

11. हाइड्रोजन परमाणु की बामर श्रेणी में, जैसे ही स्पेक्ट्रमी रेखाओं की तरंगदैर्घ्य घटती है वह प्रतीत होती हैं 1

(A) समान दूरी और समान तीव्रता

(B) एक-दूसरे से अधिक दूरी पर तथा तीव्रता में अधिक प्रबल

(C) एक-दूसरे के निकट दूरी पर तथा तीव्रता में अधिक प्रबल

(D) एक-दूसरे के निकट दूरी पर तथा तीव्रता में अधिक दुर्बल

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6. The quantum nature of light explains the observations on photoelectric effect as – **1**

(A) there is a minimum frequency of incident radiation below which no electrons are emitted.

(B) the maximum kinetic energy of photoelectrons depends only on the frequency of incident radiation.

(C) when the metal surface is illuminated, electrons are ejected from the surface after sometime.

(D) the photoelectric current is independent of the intensity of incident radiation.

7. The phase difference between electric field $\vec{E}$ and magnetic field $\vec{B}$ in an electromagnetic wave propagating along z-axis is – **1**

(A) zero (B) π

(C) $\frac{\pi}{2}$ (D) $\frac{\pi}{4}$

8. The radius (r_n) of n^{th} orbit in Bohr model of hydrogen atom varies with n as **1**

(A) $r_n \propto n$ (B) $r_n \propto \frac{1}{n}$

(C) $r_n \propto n^2$ (D) $r_n \propto \frac{1}{n^2}$

9. An ac source V = 282 sin (100 t) volt is connected across a 1 μF capacitor. The rms value of current in the circuit will be (take $\sqrt{2} = 1.41$) **1**

(A) 10 mA (B) 20 mA

(C) 40 mA (D) 80 mA

10. A galvanometer of resistance 100 Ω is converted into an ammeter of range (0 – 1 A) using a resistance of 0.1 Ω. The ammeter will show full scale deflection for a current of about **1**

(A) 0.1 mA (B) 1 mA

(C) 10 mA (D) 0.1 A

11. In Balmer series of hydrogen atom, as the wavelength of spectral lines decreases, they appear **1**

(A) equally spaced and equally intense.

(B) further apart and stronger in intensity.

(C) closer together and stronger in intensity.

(D) closer together and weaker in intensity.

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12. N फेरों की कोई कुण्डली किसी चुम्बकीय क्षेत्र $\vec{B}$ में इस प्रकार स्थित है कि चुम्बकीय क्षेत्र $\vec{B}$ कुण्डली के तल के लम्बवत है। $\vec{B}$ में समय के साथ $B = B_0 \cos\left(\frac{2\pi}{T}t\right)$ के रूप में परिवर्तन होता है, यहाँ T आवर्तकाल है। कुण्डली में प्रेरित emf का परिमाण जिस समय पर अधिकतम होगा वह है **1**

(A) $t = \frac{nT}{8}$ (B) $t = \frac{nT}{4}$

(C) $t = \frac{nT}{2}$ (D) $t = nT$

यहाँ, $n = 1, 2, 3, 4, \ldots$

नोट : प्रश्न संख्या **13** से **16** में दो कथन दिए गए हैं – एक को **अभिकथन (A)** तथा दूसरे को **कारण (R)** लेबल किया गया है। इन प्रश्नों के सही उत्तरों का नीचे दिए कोड **(A), (B), (C)** और **(D)** में से चयन कीजिए :

(A) अभिकथन (A) और कारण (R) दोनों सत्य हैं और कारण (R) अभिकथन (A) की सही व्याख्या है।

(B) अभिकथन (A) और कारण (R) दोनों सत्य हैं और कारण (R) अभिकथन (A) की सही व्याख्या नहीं है।

(C) अभिकथन (A) सत्य है और कारण (R) असत्य है।

(D) यदि दोनों अभिकथन (A) और कारण (R) असत्य हैं।

13. **अभिकथन (A) :** प्रकाश के व्यतिकरण और विवर्तन में प्रकाश ऊर्जा एक प्रदेश में घट जाती है और कोई काली फ्रिंज उत्पन्न करती है। किसी अन्य प्रदेश में यह बढ़ जाती है और कोई चमकीली फ्रिंज उत्पन्न करती है।

कारण (R) : ऐसा इस कारण से होता है, क्योंकि व्यतिकरण और विवर्तन की परिघटनाओं में ऊर्जा का संरक्षण नहीं होता है। **1**

14. **अभिकथन (A) :** जब किसी चालक में इलेक्ट्रॉन का अपवाह होता है तो इसका यह अर्थ नहीं होता है कि उस चालक के सभी मुक्त इलेक्ट्रॉन समान दिशा में गतिमान हैं।

कारण (R) : अपवाह वेग इलेक्ट्रॉनों के बृहत् यादृच्छिक वेगों पर अध्यारोपित होता है। **1**

15. **अभिकथन (A) :** पीले प्रकाश द्वारा किरणित किए जाने पर जिंक के पृष्ठ से इलेक्ट्रॉनों का उत्सर्जन होता है।

कारण (R) : जिंक के कार्यफलन की तुलना में पीले प्रकाश के फोटॉन से संबद्ध ऊर्जा अधिक होती है। **1**

16. **अभिकथन (A) :** धातुओं के लिए प्रतिरोध ताप गुणांक धनात्मक तथा p-प्रकार के अर्धचालकों के लिए प्रतिरोध ताप गुणांक ऋणात्मक होता है।

कारण (R) : धातुओं में आवेश वाहक ऋणावेशित होते हैं जबकि p-प्रकार के अर्धचालकों में बहुसंख्यक आवेश वाहक धनावेशित होते हैं। **1**

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12. A coil of N turns is placed in a magnetic field $\vec{B}$ such that $\vec{B}$ is perpendicular to the plane of the coil. $\vec{B}$ changes with time as $B = B_0 \cos\left(\frac{2\pi}{T}t\right)$ where T is time period. The magnitude of emf induced in the coil will be maximum at **1**

(A) $t = \frac{nT}{8}$ (B) $t = \frac{nT}{4}$

(C) $t = \frac{nT}{2}$ (D) $t = nT$

Here, n = 1, 2, 3, 4, ...

Note : For questions number **13** to **16**, two statements are given – one labelled **Assertion (A)** and the other labelled **Reason (R)**. Select the correct answer to these questions from the codes **(A)**, **(B)**, **(C)** and **(D)** as given below :

(A) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) If both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of Assertion (A).

(C) If Assertion (A) is true and Reason (R) is false.

(D) If both Assertion (A) and Reason (R) are false.

13. **Assertion (A) :** In interference and diffraction of light, light energy reduces in one region producing a dark fringe. It increases in another region and produces a bright fringe.
Reason (R) : This happens because energy is not conserved in the phenomena of interference and diffraction. **1**

14. **Assertion (A) :** When electrons drift in a conductor, it does not mean that all free electrons in the conductor are moving in the same direction.
Reason (R) : The drift velocity is superposed over large random velocities of electrons. **1**

15. **Assertion (A) :** Electrons are ejected from the surface of zinc when it is irradiated by yellow light.
Reason (R) : Energy associated with a photon of yellow light is more than the work function of zinc. **1**

16. **Assertion (A) :** The temperature coefficient of resistance is positive for metals and negative for p-type semiconductors.
Reason (R) : The charge carriers in metals are negatively charged, whereas the majority charge carriers in p-type semiconductors are positively charged. **1**

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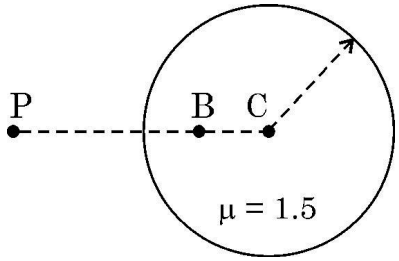
खण्ड – ख

$5 \times 2 = 10$

17. (a) आरेख में दर्शाए अनुसार अपवर्तनांक 1.5 और त्रिज्या 40 cm के किसी काँच के गोले में कोई वायु का बुलबुला बिन्दु B (CB = 20 cm) पर फंस गया है । बिन्दु P से प्रेक्षण करने पर इस बुलबुले के प्रतिबिम्ब की प्रकृति और स्थिति ज्ञात कीजिए । **2**



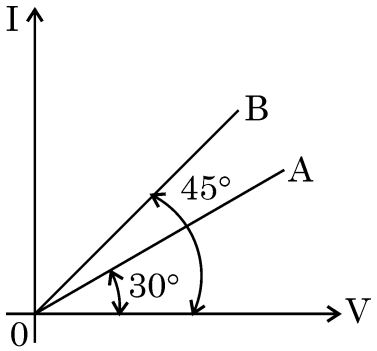
अथवा

(b) किसी अपवर्ती दूरदर्शक के सामान्य समायोजन में अभिदृश्यक और अभिनेत्र लेंस के बीच की दूरी 1.00 m है । यदि इस दूरदर्शक की आवर्धन क्षमता 19 है, तो अभिदृश्यक और अभिनेत्र लेंस की फोकस दूरी ज्ञात कीजिए । **2**

18. द्रव्य तरंगें किन्हें कहते हैं ? किसी प्रोटॉन, किसी इलेक्ट्रॉन और किसी आल्फा कण की गतिज ऊर्जा समान है । इनसे संबद्ध दे ब्रोग्ली तरंगदैर्ध्यों को आरोही (बढ़ते) क्रम में लिखिए । **2**

19. कोई प्रकाश किरण अपवर्तनांक μ के समबाहु काँच के प्रिज्म के फलक पर अभिलम्बवत् आपतन करती है । जब इस प्रिज्म को किसी पारदर्शी माध्यम में पूर्णतः डुबोया जाता है तो यह प्रेक्षण किया जाता है कि निर्गत किरण संलग्न फलक को ठीक–ठीक स्पर्श करती है । इस माध्यम का अपवर्तनांक ज्ञात कीजिए । **2**

20. विभिन्न धातुओं के दो तारों A और B की क्रमशः लम्बाइयों का अनुपात 1 : 2 तथा त्रिज्याओं का अनुपात 2 : 1 है । आरेख में इनके I-V ग्राफ दर्शाए गए हैं । इनके (i) प्रतिरोधों का अनुपात (R_A/R_B) तथा इनकी (ii) प्रतिरोधकताओं (σ_A/σ_B) का अनुपात ज्ञात कीजिए । **2**



21. किसी p-n संधि डायोड का (i) अग्रदिशिक बायसन और (ii) पश्चदिशिक बायसन में परिपथ आरेख खींचिए । इन दोनों प्रकरणों में I-V अभिलाक्षणिक भी खींचिए । **2**

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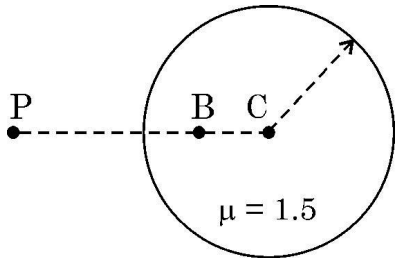
SECTION – B $5 \times 2 = 10$

17. (a) An air bubble is trapped at point B (CB = 20 cm) in a glass sphere of radius 40 cm and refractive index 1.5 as shown in figure. Find the nature and position of the image of the bubble as seen by an observer at point P. **2**



OR

(b) In normal adjustment, for a refracting telescope, the distance between objective and eye piece lens is 1.00 m. If the magnifying power of the telescope is 19, find the focal length of the objective and the eyepiece lens. **2**

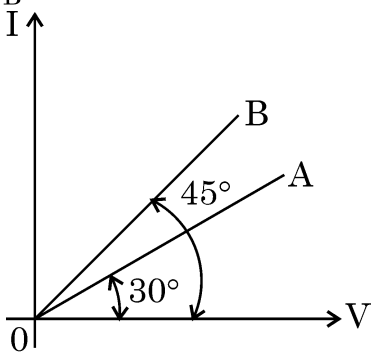
18. What are matter waves ? A proton, an electron and an α-particle have the same kinetic energy. Write the de Broglie wavelengths associated with them in increasing order. **2**

19. A ray of light is incident normally on one face of an equilateral glass prism of refractive index μ. When the prism is completely immersed in a transparent medium, it is observed that the emergent ray just grazes the adjacent face. Find the refractive index of the medium. **2**

20. Two wires A and B of different metals have their lengths in ratio 1 : 2 and their radii in ratio 2 : 1 respectively. I-V graphs for them is shown in the figure. Find the ratio of their **2**

(i) Resistances (R_A/R_B) and

(ii) Resistivities (σ_A/σ_B)



21. Draw the circuit diagram of a p-n junction diode in (i) forward biasing and (ii) reverse biasing. Also draw its I-V characteristics in the two cases. **2**

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खण्ड – ग $7 \times 3 = 21$

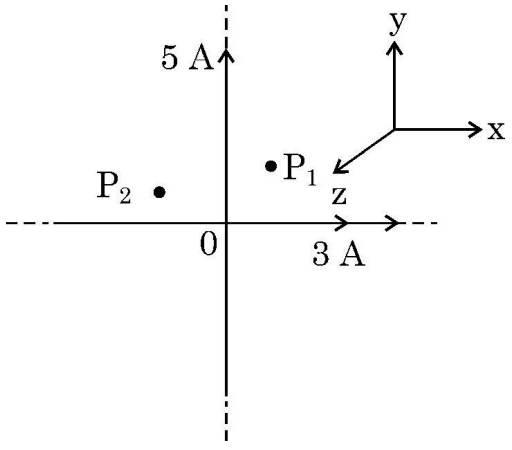
22. गाइगर मार्शडेन प्रयोग में प्रकीर्णन कोण (θ) के साथ संसूचित प्रकीर्णित कणों (N) के विचरण को दर्शाने के लिए ग्राफ खींचिए । इस ग्राफ द्वारा आप जिन दो निष्कर्षों को निकाल सकते हैं, उन्हें लिखिए । इस प्रयोग में उपगमन की निकटतम दूरी के लिए व्यंजक प्राप्त कीजिए । **3**

23. त्रिज्या R के किसी पतली गोलीय चालक खोल पर आवेश q है । एक बिन्दु आवेश Q इस खोल के केन्द्र पर स्थित है । (i) इस खोल के बाहरी पृष्ठ पर आवेश घनत्व तथा (ii) इस खोल के केन्द्र से (R/2) दूरी पर विभव ज्ञात कीजिए । **3**

24. (a) नाभिकीय विखण्डन और नाभिकीय संलयन के बीच विभेदन कीजिए । **3**

(b) ${}_{94}Pu^{239}$ के विखण्डन गुणों और ${}_{92}U^{235}$ के विखण्डन-गुणों में अत्यधिक समानता है । यदि शुद्ध ${}_{94}Pu^{239}$ के 1 g के सभी परमाणुओं का विखण्डन हो जाए, तो कितनी ऊर्जा (MeV में) मुक्त होगी ? प्रति विखण्डन मुक्त औसत ऊर्जा 180 MeV है ।

25. आरेख में XY तल में व्यवस्थित दो लम्बे विद्युत रोधी सीधे तारों, जिनसे 3 A और 5 A धाराएँ प्रवाहित हो रही हैं, को दर्शाया गया है । बिन्दुओं $P_1(2m, 2m)$ तथा $P_2(-1m, 1m)$ पर शुद्ध चुम्बकीय क्षेत्रों के परिमाण और दिशाएँ ज्ञात कीजिए । **3**



26. विस्थापन धारा से क्या तात्पर्य है ? यह धारा चालन धारा से किस प्रकार भिन्न है ? किसी संधारित्र को किसी emf के स्रोत द्वारा आवेशित किया जा रहा है । परिपथ में धारा की निरन्तरता की पुष्टि कीजिए । **3**

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SECTION – C $7 \times 3 = 21$

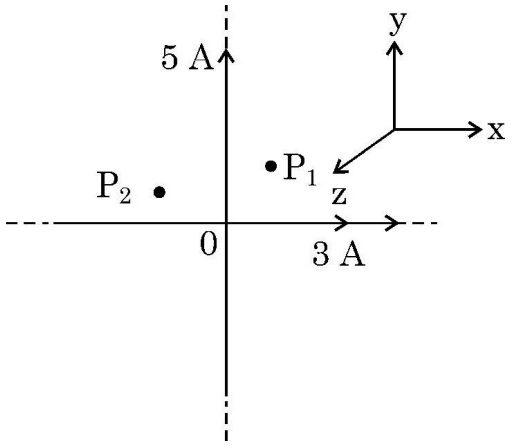
22. Draw the graph showing variation of scattered particles detected (N) with the scattering angle (θ) in Geiger-Marsden experiment. Write two conclusions that you can draw from this graph. Obtain the expression for the distance of closest approach in this experiment. **3**

23. A thin spherical conducting shell of radius R has a charge q. A point charge Q is placed at the centre of the shell. Find (i) The charge density on the outer surface of the shell and (ii) the potential at a distance of (R/2) from the centre of the shell. **3**

24. (a) Differentiate between nuclear fission and fusion. **3**

    (b) The fission properties of $_{94}Pu^{239}$ are very similar to those of $_{92}U^{235}$. How much energy (in MeV), is released if all the atoms in 1 g of pure $_{94}Pu^{239}$ undergo fission ? The average energy released per fission is 180 MeV.

25. Two long insulated straight wires carrying currents of 3 A and 5 A are arranged in XY plane as shown in figure. Find the magnitude and direction of the net magnetic fields at points $P_1(2m, 2m)$ and $P_2(-1m, 1m)$. **3**



26. What is meant by displacement current ? How is this current different from the conduction current ? A capacitor is being charged by a source of emf. Justify the continuity of current in the circuit. **3**

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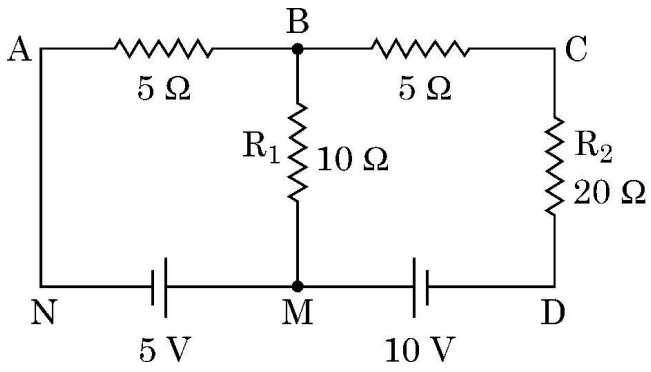
27. दर्शाए गए नेटवर्क की शाखाओं AB तथा BC से प्रवाहित धाराएँ ज्ञात कीजिए । **3**



28. (a) (i) अन्योन्य प्रेरकत्व की परिभाषा और इसका SI मात्रक लिखिए । **3**

(ii) दो लंबी समाक्ष परिनालिकाओं, जिनकी लम्बाई समान l, फेरों की संख्या N_1 और N_2 तथा त्रिज्या r_1 और r_2 ($>r_1$) हैं, के बीच अन्योन्य प्रेरकत्व के लिए व्यंजक व्युत्पन्न कीजिए ।

अथवा

(b) लौह चुम्बकीय पदार्थ किन्हें कहते हैं ? चुम्बकीय डोमेन की संकल्पना का उपयोग करके उपयुक्त आरेख की सहायता से लौह चुम्बकत्व की व्याख्या कीजिए । **3**

खण्ड – घ

$2 \times 4 = 8$

नोट : प्रश्न संख्या **29** से **30** केस आधारित प्रश्न हैं । नीचे दिए गए अनुच्छेद का अध्ययन करके प्रश्नों के उत्तर दीजिए ।

29. कोई लेंस दो पृष्ठों से घिरा ऐसा पारदर्शी प्रकाशिक माध्यम होता है जिसके दोनों पृष्ठों में कम से कम एक गोलीय होना चाहिए । किसी एकल गोलीय पृष्ठ द्वारा निर्मित प्रतिबिम्ब के लिए सूत्र का उपयोग किसी लेंस के दो पृष्ठों पर क्रमिक रूप में करके पतले लेंसों के लिए लेंस सूत्र जिसे लेंस मेकर सूत्र और इस प्रकार मूल लेंस सूत्र प्राप्त किया जाता है । किसी लेंस की फोकस दूरी (अथवा क्षमता) लेंस के दोनों पृष्ठों की त्रिज्याओं तथा प्रतिवेश के सापेक्ष लेंस के पदार्थ के अपवर्तनांक पर निर्भर करता है । किसी पदार्थ का अपवर्तनांक उपयोग किए गए प्रकाश की तरंगदैर्ध्य पर निर्भर करता है । लेंसों का संयोजन वांछित क्षमता और आवर्धन के अपसारी और अभिसारी लेंसों को प्राप्त करने में हमारी सहायता करता है । **$4 \times 1 = 4$**

(i) 20 cm फोकस दूरी का कोई पतला अपसारी लेंस 15 cm फोकस दूरी के पतले अभिसारी लेंस के सम्पर्क में समाक्ष रखा है । इस संयोजन की क्षमता है –

(A) $\frac{-5}{6}$ D (B) $\frac{-5}{3}$ D

(C) $\frac{4}{3}$ D (D) $\frac{3}{2}$ D

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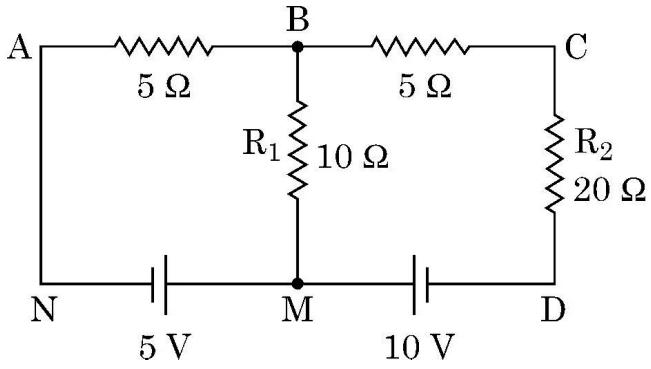
27. Find the currents flowing through the branches AB and BC in the network shown. **3**



28. (a) (i) Define mutual inductance. Write its SI unit. **3**

(ii) Derive an expression for the mutual inductance of a system of two long coaxial solenoids of same length l, having turns N_1 and N_2 and of radii r_1 and r_2 ($> r_1$).

OR

(b) What are ferromagnetic materials ? Explain ferromagnetism with the help of suitable diagrams, using the concept of magnetic domain. **3**

SECTION – D

2 × 4 = 8

Note : Questions number **29** to **30** are Case Study based questions. Read the following paragraph and answer the questions that follow.

29. A lens is a transparent optical medium bounded by two surfaces; at least one of which should be spherical. Applying the formula of image formation by a single spherical surface successively at the two surfaces of a thin lens, a formula known as lens maker's formula and hence the basic lens formula can be obtained. The focal length (or power) of a lens depends on the radii of its surfaces and the refractive index of its material with respect to the surrounding medium. The refractive index of a material depends on the wavelength of light used. Combination of lenses helps us to obtain diverging or converging lenses of desired power and magnification. **4 × 1 = 4**

(i) A thin converging lens of focal length 20 cm and a thin diverging lens of focal length 15 cm are placed coaxially in contact. The power of the combination is

(A) $\frac{-5}{6}$ D

(B) $\frac{-5}{3}$ D

(C) $\frac{4}{3}$ D

(D) $\frac{3}{2}$ D

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(ii) किसी उत्तल लेंस के दो पृष्ठों की वक्रता त्रिज्या R और 2R हैं । यदि इस लेंस की फोकस दूरी $\left(\frac{4}{3}\right)$ R है, तो लेंस के पदार्थ का अपवर्तनांक है :

(A) $\frac{5}{3}$ (B) $\frac{4}{3}$

(C) $\frac{3}{2}$ (D) $\frac{7}{5}$

(iii) किसी समतलोत्तल लेंस की फोकस दूरी

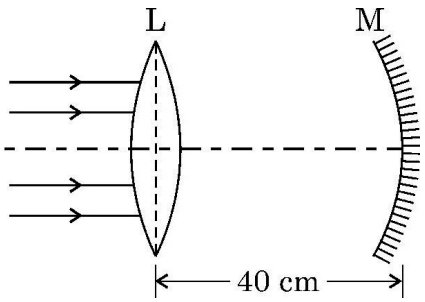
(A) पानी में डुबोने पर बढ़ जाती है ।

(B) आपतित प्रकाश की तरंगदैर्ध्य में कमी होने पर बढ़ जाती है ।

(C) इसके पृष्ठों की वक्रता त्रिज्या में कमी होने पर बढ़ जाती है ।

(D) मुख्य अक्ष के अनुदिश दो सर्वसम भागों में काटे जाने पर घट जाती है ।

(iv) (a) आरेख में दर्शाए अनुसार 10 cm फोकस दूरी का कोई उत्तल पतला लेंस L और 15 cm फोकस दूरी का कोई अवतल दर्पण M एक-दूसरे से 40 cm की दूरी पर समाक्ष स्थित हैं । मुख्य अक्ष से समान्तर कोई प्रकाश पुन्ज लेंस पर आपतन करता है । अंतिम प्रतिबिम्ब लेंस के सापेक्ष कहाँ और कितनी दूरी पर बनेगा ?



(A) 10 cm, लेंस के बायीं ओर (B) 10 cm, लेंस के दायीं ओर

(C) 20 cm, लेंस के बायीं ओर (D) 20 cm, लेंस के दायीं ओर

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(iv) (b) 16 cm फोकस दूरी के किसी उत्तल लेंस L_1 पर कोई प्रकाश पुन्ज, जो लेंस के मुख्य अक्ष के समान्तर है, आपतन कर रहा है । लेंस L_1 के समाक्ष कोई अन्य उत्तल लेंस L_2 जिसकी फोकस दूरी 12 cm है, 40 cm दूरी पर स्थित है । अंतिम प्रतिबिम्ब की प्रकृति और लेंस L_2 से दूरी होगी क्रमश:

(A) वास्तविक, 24 cm (B) आभासी, 12 cm

(C) वास्तविक, 32 cm (D) आभासी, 18 cm

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(ii) The radii of curvature of two surfaces of a convex lens are R and 2R. If the focal length of this lens is $\left(\frac{4}{3}\right)$R, the refractive index of the material of the lens is :

(A) $\frac{5}{3}$ (B) $\frac{4}{3}$

(C) $\frac{3}{2}$ (D) $\frac{7}{5}$

(iii) The focal length of an equiconvex lens

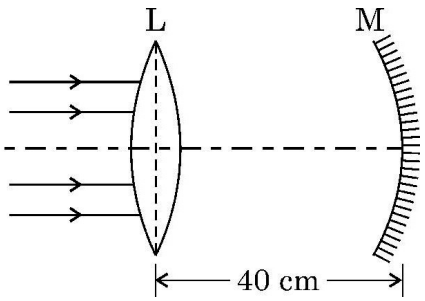
(A) increases when the lens is dipped in water.

(B) increases when the wavelength of incident light decreases.

(C) increases with decrease in radius of curvature of its surface.

(D) decreases when the lens is cut into two identical parts along its principal axis.

(iv) (a) A thin convex lens L of focal length 10 cm and a concave mirror M of focal length 15 cm are placed coaxially 40 cm apart as shown in figure. A beam of light coming parallel to the principal axis is incident on the lens. The final image will be formed at a distance of



(A) 10 cm, left of lens (B) 10 cm, right of lens

(C) 20 cm, left of lens (D) 20 cm, right of lens

OR

(iv) (b) A beam of light coming parallel to the principal axis of a convex lens L_1 of focal length 16 cm is incident on it. Another convex lens L_2 of focal length 12 cm is placed coaxially at a distance 40 cm from L_1. The nature and distance of the final image from L_2 will be

(A) real, 24 cm (B) virtual, 12 cm

(C) real, 32 cm (D) virtual, 18 cm

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30. Ge या Si जैसे शुद्ध अर्धचालकों का जब किसी उचित अपद्रव्य की अल्प मात्रा से मादन किया जाता है तो वह अपद्रव्यी अर्धचालक बन जाते हैं । तापीय साम्य में इनमें इलेक्ट्रॉन और विवर सांद्रता नैज आवेश वाहकों की सांद्रता से संबंधित होती है । उचित अपद्रव्य से भारित करने पर कोई p-प्रकार अथवा n-प्रकार का अर्धचालक p-n संधि में परिवर्तित किया जा सकता है । किसी p-n संधि के निर्माण में दो प्रक्रियाएँ विसरण और अपवाह होती हैं । कोई अर्धचालक डायोड मूल रूप से कोई p-n संधि ही होता है जिसके दो सिरों पर बाह्य वोल्टता के अनुप्रयोग के लिए धातु–संस्पर्श प्रदान किए जाते हैं । अग्र दिशिक बायसित होने पर कोई p-n संधि धारा को केवल एक ही दिशा में प्रवाहित होने देती है । इसी गुण के कारण किसी डायोड का उपयोग विस्तृत रूप में, अर्ध तरंग अथवा पूर्ण तरंग अभिविन्यासों में प्रत्यावर्ती (ac) वोल्टताओं के दिष्टकरण के लिए किया जाता है । **4 × 1 = 4**

(i) जब Ge का मादन पंचसंयोजक अपद्रव्य के साथ किया जाता है, तो अपमिश्रक से दुर्बल–बंध से जुड़े इलेक्ट्रॉन को मुक्त कराने के लिए आवश्यक ऊर्जा होती है लगभग

(A) 0.001 eV (B) 0.01 eV

(C) 0.72 eV (D) 1.1 eV

(ii) किसी दिए ताप पर किसी अर्धचालक में नैज आवेश वाहकों की संख्या $2.0 \times 10^{10}\ cm^{-3}$ है । इसका मादन पंचसंयोजक अपद्रव्यी परमाणुओं से किया गया है । इसके परिणामस्वरूप इसमें विवरों (होलों) की संख्या $8 \times 10^{3}\ cm^{-3}$ हो जाती है । इस अर्धचालक में इलेक्ट्रॉनों की संख्या है

(A) $2 \times 10^{24}\ m^{-3}$ (B) $4 \times 10^{23}\ m^{-3}$

(C) $1 \times 10^{22}\ m^{-3}$ (D) $5 \times 10^{22}\ m^{-3}$

(iii) (a) किसी p-n संधि के बनते समय

(A) इलेक्ट्रॉनों का p-क्षेत्र से n-क्षेत्र की ओर विसरण होता है तथा होलों का n-क्षेत्र से p-क्षेत्र की ओर विसरण होता है ।

(B) इलेक्ट्रॉन और होल दोनों का ही n-क्षेत्र से p-क्षेत्र की ओर विसरण होता है ।

(C) इलेक्ट्रॉनों का n-क्षेत्र से p-क्षेत्र की ओर विसरण होता है तथा होलों का p-क्षेत्र से n-क्षेत्र की ओर विसरण होता है ।

(D) इलेक्ट्रॉनों और होल दोनों का ही p-क्षेत्र से n-क्षेत्र की ओर विसरण होता है ।

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(iii) (b) किसी p-n संधि के बनते समय आरम्भ में

(A) विसरण धारा बृहत् तथा अपवाह धारा लघु होती है ।

(B) विसरण धारा लघु तथा अपवाह धारा बृहत् होती है ।

(C) विसरण धारा तथा अपवाह धारा दोनों हीं बृहत होती हैं ।

(D) विसरण धारा तथा अपवाह धारा दोनों हीं लघु होती हैं ।

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30. A pure semiconductor like Ge or Si, when doped with a small amount of suitable impurity, becomes an extrinsic semiconductor. In thermal equilibrium, the electron and hole concentration in it are related to the concentration of intrinsic charge carriers. A p-type or n-type semiconductor can be converted into a p-n junction by doping it with suitable impurity. Two processes, diffusion and drift take place during formation of a p-n junction. A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for the application of an external voltage. A p-n junction diode allows currents to pass only in one direction when it is forward biased. Due to this property, a diode is widely used to rectify alternating voltages, in half-wave or full wave configuration. **4 × 1 = 4**

(i) When Ge is doped with pentavalent impurity, the energy required to free the weakly bound electron from the dopant is about

(A) 0.001 eV (B) 0.01 eV

(C) 0.72 eV (D) 1.1 eV

(ii) At a given temperature, the number of intrinsic charge carriers in a semiconductor is 2.0×10^{10} cm^{-3}. It is doped with pentavalent impurity atoms. As a result, the number of holes in it becomes 8×10^{3} cm^{-3}. The number of electrons in the semiconductor is

(A) 2×10^{24} m^{-3} (B) 4×10^{23} m^{-3}

(C) 1×10^{22} m^{-3} (D) 5×10^{22} m^{-3}

(iii) (a) During the formation of a p-n junction –

(A) electrons diffuse from p-region into n-region and holes diffuse from n-region into p-region.

(B) both electrons and holes diffuse from n-region into p-region.

(C) electrons diffuse from n-region into p-region and holes diffuse from p-region into n-region.

(D) both electrons and holes diffuse from p-region into n-region.

OR

(iii) (b) Initially during the formation of a p-n junction –

(A) diffusion current is large and drift current is small.

(B) diffusion current is small and drift current is large.

(C) both the diffusion and the drift currents are large.

(D) both the diffusion and the drift currents are small.

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(iv) किसी ac वोल्टता $V = 0.5 \sin (100 \pi t)$ वोल्ट को बारी-बारी से किसी अर्ध तरंग दिष्टकारी तथा पूर्ण तरंग दिष्टकारी के सिरों से संयोजित किया गया है । इनके सिरों पर निर्गत वोल्टता की आवृत्ति क्रमशः होगी

(A) 25 Hz, 50 Hz (B) 25 Hz, 100 Hz

(C) 50 Hz, 50 Hz (D) 50 Hz, 100 Hz

खण्ड – ङ **$3 \times 5 = 15$**

31. (a) (i) उन कारकों का उल्लेख कीजिए जिन पर किसी LCR श्रेणी परिपथ की अनुनाद की आवृत्ति निर्भर करती है । अनुप्रयुक्त ac स्रोत की आवृत्ति के साथ LCR श्रेणी परिपथ की प्रतिबाधा में विचरण को दर्शाने के लिए ग्राफ खींचिए ।

(ii) उपयुक्त आरेख की सहायता से किसी उच्चायी ट्रान्सफॉर्मर की कार्यविधि की व्याख्या कीजिए ।

(iii) किसी वास्तविक ट्रान्सफॉर्मर में ऊर्जा-क्षय के दो कारण लिखिए । **5**

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(b) (i) आरेख की सहायता से किसी ac जनित्र की संरचना और कार्यविधि की संक्षेप में व्याख्या कीजिए ।

(ii) कोई इलेक्ट्रॉन किसी प्रोटॉन की परिक्रमा त्रिज्या r की कक्षा में चाल v से कर रहा है । इस इलेक्ट्रॉन से संबद्ध चुम्बकीय आघूर्ण के लिए व्यंजक प्राप्त कीजिए । **5**

32. (a) (i) किसी समान्तर पट्टिका संधारित्र जिसकी पट्टिकाओं के बीच पृथकन d तथा पट्टिकाओं का क्षेत्रफल A है, की पट्टिकाओं के बीच परावैद्युतांक 'K' और मोटाई 't' का कोई गुटका रखा गया है । इस संधारित्र की धारिता के लिए व्यंजक प्राप्त कीजिए ।

(ii) दो विभिन्न धारिताओं के संधारित्रों को पहले (1) श्रेणी में और फिर (2) पार्श्व में किसी 100 V के dc स्रोत से संयोजित किया गया है । यदि इन दोनों प्रकरणों में संयोजनों में संचित कुल ऊर्जा क्रमशः 40 mJ और 250 mJ हैं, तो इन संधारित्रों की धारिताएँ ज्ञात कीजिए । **5**

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(iv) An ac voltage V = 0.5 sin (100 πt) volt is applied, in turn, across a half-wave rectifier and a full-wave rectifier. The frequency of the output voltage across them respectively will be

(A) 25 Hz, 50 Hz (B) 25 Hz, 100 Hz

(C) 50 Hz, 50 Hz (D) 50 Hz, 100 Hz

SECTION – E

3 × 5 = 15

31. (a) (i) Mention the factors on which the resonant frequency of a series LCR circuit depends. Plot a graph showing variation of impedance of a series LCR circuit with the frequency of the applied a.c. source.

(ii) With the help of a suitable diagram, explain the working of a step-up transformer.

(iii) Write two causes of energy loss in a real transformer. **5**

OR

(b) (i) With the help of a diagram, briefly explain the construction and working of ac generator.

(ii) An electron is revolving around a proton in an orbit of radius r with a speed v. Obtain expression for magnetic moment associated with the electron. **5**

32. (a) (i) A dielectric slab of dielectric constant 'K' and thickness 't' is inserted between plates of a parallel plate capacitor of plate separation d and plate area A. Obtain an expression for its capacitance.

(ii) Two capacitors of different capacitances are connected first (1) in series and then (2) in parallel across a dc source of 100 V. If the total energy stored in the combination in the two cases are 40 mJ and 250 mJ respectively, find the capacitance of the capacitors. **5**

OR

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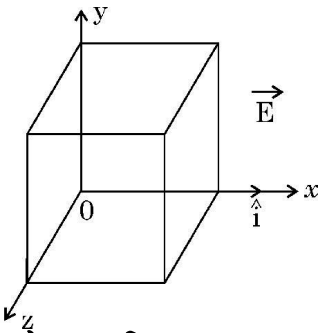
(b) (i) गाउस नियम का उपयोग करके यह दर्शाइए कि किसी एकसमान आवेशित अनन्त समतल चादर के कारण किसी बिन्दु पर विद्युत क्षेत्र $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ से व्यक्त होता है । यहाँ प्रतीकों के अपने सामान्य अर्थ हैं ।

(ii) किसी प्रदेश में विद्युत क्षेत्र $\vec{E}$ को इस प्रकार व्यक्त किया गया है

$$\vec{E} = (5x^2 + 2)\hat{i}$$

यहाँ E को N/C तथा x को मीटरों में व्यक्त किया गया है ।
इस प्रदेश में भुजा 10 cm के किसी घन को आरेख में दर्शाए अनुसार स्थित किया गया है । परिकलित कीजिए ।



(1) इस घन से गुजरने वाला विद्युत फ्लक्स, तथा

(2) इस घन द्वारा परिबद्ध नेट आवेश । **5**

33. (a) (i) किसी उत्तल दर्पण द्वारा किसी बिम्ब का प्रतिबिम्ब बनना दर्शाने के लिए किरण आरेख खींचिए और इससे दर्पण समीकरण प्राप्त कीजिए ।

(ii) प्रकाशिक यंत्रों के अभिदृश्यक और अभिनेत्र लेंस (नेत्रिका) दोनों के लिए बहुघटक लेंसों का उपयोग क्यों किया जाता है ?

(iii) किसी संयुक्त सूक्ष्मदर्शी द्वारा किसी लघु बिम्ब का आवर्धन 200 है । नेत्रिका की फोकस दूरी 2 cm है तथा अंतिम प्रतिबिम्ब अनन्त पर बनता है । अभिदृश्यक द्वारा उत्पन्न आवर्धन ज्ञात कीजिए । **5**

अथवा

(b) (i) किसी तरंगाग्र और किसी किरण के बीच विभेदन कीजिए ।

(ii) हाइगेन्स सिद्धान्त लिखिए तथा उपयुक्त आरेख का उपयोग करके परावर्तन के नियमों का सत्यापन कीजिए ।

(iii) यंग के द्विझिरी प्रयोग में झिरियों S_1 और S_2 के बीच की दूरी 3 mm है तथा पर्दे की झिरियों से दूरी 1.0 m है । यह प्रेक्षण किया गया है कि चौथी चमकीली फ्रिन्ज दूसरी काली फ्रिन्ज से 5 mm की दूरी पर है । उपयोग किए जाने वाले प्रकाश की तरंगदैर्ध्य ज्ञात कीजिए । **5**

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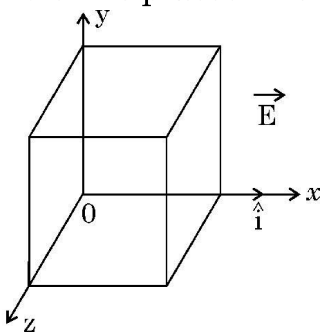
(b) (i) Using Gauss's law, show that the electric field $\vec{E}$ at a point due to a uniformly charged infinite plane sheet is given by $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ where symbols have their usual meanings.

(ii) Electric field $\vec{E}$ in a region is given by
$\vec{E} = (5x^2 + 2)\hat{i}$
where E is in N/C and x is in meters.
A cube of side 10 cm is placed in the region as shown in figure.



Calculate (1) the electric flux through the cube, and (2) the net charge enclosed by the cube. **5**

33. (a) (i) Draw a ray diagram for the formation of the image of an object by a convex mirror. Hence, obtain the mirror equation.

(ii) Why are multi-component lenses used for both the objective and the eyepiece in optical instruments ?

(iii) The magnification of a small object produced by a compound microscope is 200. The focal length of the eyepiece is 2 cm and the final image is formed at infinity. Find the magnification produced by the objective. **5**

OR

(b) (i) Differentiate between a wavefront and a ray.

(ii) State Huygen's principle and verify laws of reflection using suitable diagram.

(iii) In Young's double slit experiment, the slits S_1 and S_2 are 3 mm apart and the screen is placed 1.0 m away from the slits. It is observed that the fourth bright fringe is at a distance of 5 mm from the second dark fringe. Find the wavelength of light used. **5**

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Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT PHYSICS (CODE 55/4/1)

General Instructions: -

1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and

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	encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks _____0 to 70___(example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

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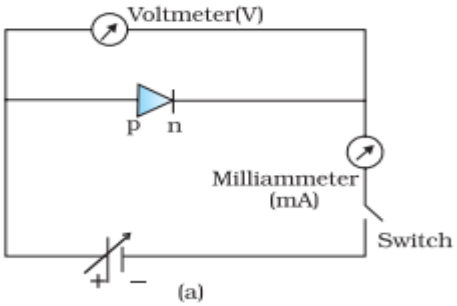
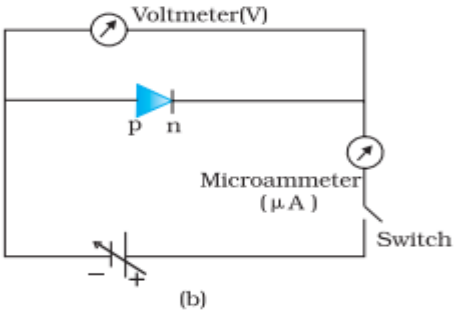
MARKING SCHEME : PHYSICS (042)			
Code : 55/04/01			
Q.NO	VALUE POINTS/EXPECTED ANSWERS	MARKS	TOTAL MARKS
SECTION - A			
1	(C) $\frac{-7q^2}{8\pi\varepsilon_0 a}$	1	1
2	(B) -3 pC	1	1
3	(A) There is a minimum frequency of incident radiation below which no electrons are emitted.	1	1
4	(C) $r_n \alpha n^2$	1	1
5	(C) North	1	1
6	(A) Small and negative.	1	1
7	(B) 1mA	1	1
8	(A) R	1	1
9	(D) $\frac{1}{3}$	1	1
10	(A) Zero	1	1
11	No option is correct, award 1 mark.	1	1
12	(D) Closer together and weaker in intensity.	1	1
13	(D) Both Assertion (A) and Reason (R) are false.	1	1
14	(B) Both assertion (A) and Reason (R) are true and Reason (R)is not the correct explanation of Assertion(A).	1	1
15	(A) Both assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion(A).	1	1
16	(C) Assertion (A) is true and Reason (R) is false.	1	1
SECTION – B			
17	Drawing of circuit diagram of p-n junction diode (i) Forward bias ½ (ii) Reverse bias ½ I-V charcteristics in forward and reverse bias ½ + ½ i)  (a)  (b)	½ ½	

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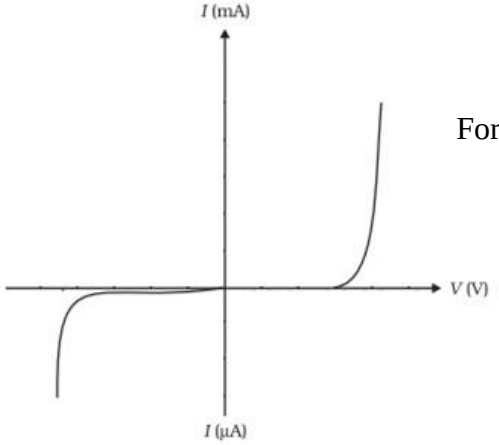
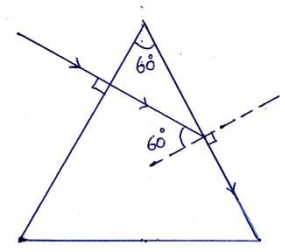
	I-V characteristics in forward and reverse bias  	½ + ½	**2**
18	Finding $\frac{V_1}{V_2}$ 2 De Broglie wavelength of a proton $\lambda_p = \frac{h}{\sqrt{2m_p q_p V_1}} = \frac{h}{\sqrt{2meV_1}}$ De Broglie wavelength of an α particle $\lambda_\alpha = \frac{h}{\sqrt{2m_\alpha q_\alpha V_2}} = \frac{h}{\sqrt{2(4m)(2e)V_2}}$ $\lambda_p = \lambda_\alpha$ $\frac{h}{\sqrt{2meV_1}} = \frac{h}{\sqrt{16meV_2}}$ $\frac{V_1}{V_2} = 8$	½ ½ ½ ½	**2**
19	Finding refractive index of the medium 2  From snell's law, $\mu.\sin i = \mu_m.\sin r$ $\mu.\sin 60^0 = \mu_m.\sin 90^0$ $\mu_m = \mu.\frac{\sqrt{3}}{2}$	½ ½ ½ ½	**2**

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	Alternatively $\mu = \frac{1}{\sin C}$ $\frac{\mu}{\mu_m} = \frac{1}{\sin 60^0}$ $\mu_m = \frac{\sqrt{3}}{2}\mu$	1 ½ ½	
20	Finding power consumed by two electric heaters in series combination 1 ½ Writing answer for parallel combination ½ $R_1 = \frac{V^2}{P_1}$ & $R_2 = \frac{V^2}{P_2}$ $R_{eq} = R_1 + R_2 = V^2\left(\frac{1}{P_1} + \frac{1}{P_2}\right)$ $P_{series} = \frac{V^2}{R_{eq}}$ $P_{series} = \frac{V^2}{V^2\left(\frac{1}{P_1} + \frac{1}{P_2}\right)}$ $\frac{1}{P_{series}} = \frac{1}{P_1} + \frac{1}{P_2}$ No	½ ½ ½ ½	**2**
21	(a) Finding nature and position of image 2 Using refraction formula at spherical surface from denser to rarer medium n_1 = refractive index of rarer medium n_2 = refractive index of denser medium $\frac{n_1}{v} - \frac{n_2}{u} = \frac{n_1 - n_2}{R}$ u = - 20 cm , R= - 40 cm , n_1 = 1 , n_2 = 1.5 $\frac{1}{v} - \frac{1.5}{(-20)} = \frac{1-1.5}{(-40)}$ v = -16 cm Nature of image is virtual. OR (b) Finding the focal lengths of the objective and eyepiece 2 Distance between objective and eyepiece fo + fe = 1.00 m = 100 cm Magnifying power $\lvert m \rvert = \frac{fo}{fe} = 19$	½ ½ ½ ½ ½ ½	**2**

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	On solving fo = 95 cm = 0.95 m fe = 5 cm = 0.05 m	 ½ ½	
	SECTION - C		
22	(a) Difference between nuclear fission and fusion (1) (b) Calculating energy released in fission (2) (a) In nuclear fission , a heavy nucleus splits into two or more lighter nuclei and energy is released. In nuclear fusion, lighter nuclei combine together a form a heavy nucleus and larger amount of energy is released. (b) Number of atoms in 1 g of $_{94}Pu^{239}$ $= \frac{6.023\times10^{23}}{239}$ $= 2.5\times10^{21}$ Energy released in fission of 1 g of $_{94}Pu^{239}$, $E = 180MeV\times2.5\times10^{21}$ $E = 4.5\times10^{23}$ MeV	 ½ ½ 1 1	**3**
23	Calculating work done in taking a unit charge from (i) (5m , 0) to (10m , 0) 2 (ii) (5m , 0) to (5m , 10m) 1 (i) $\Delta V = -\int_{x_1}^{x_2} E\,dx$ $\Delta V = -\int_{5}^{10}(10x+4)dx = -\left[\frac{10x^2}{2}+4x\right]_5^{10}$ $= -395$ V $W = q\Delta V = -395\times1$ $= -395$ J (ii) $\Delta V = -\int_{x_1}^{x_2} E\,dx$ $\Delta V = -\int_{5}^{5}(10x+4)dx = 0$ $W = q.\Delta V = 0$ **Alternatively** If a student writes, displacement is perpendicular to electric field then $\Delta V = 0$ $W = q.\Delta V = 0$ Award full credit for part (ii)	 ½ ½ ½ ½ ½ ½ ½ ½	**3**

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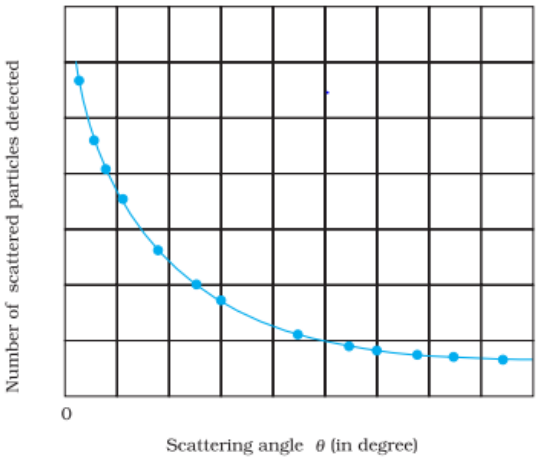
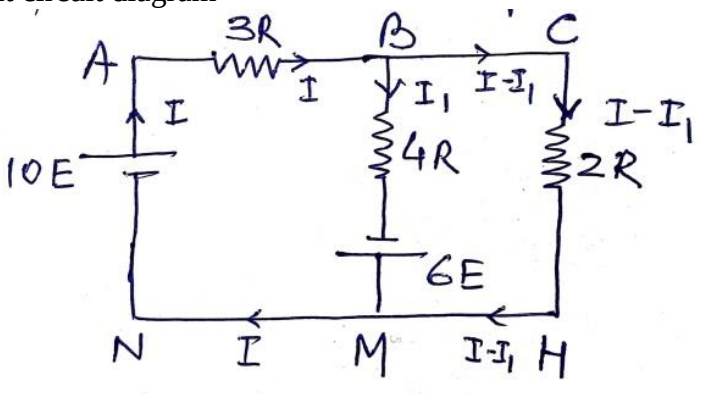
24	Drawing graph showing variation of scattered particles detected(N) with scattering angle(θ) 1 Two conclusions 1 Obtaining expression for the distance of closest approach 1		
		1	
	Two conclusions (i) Most of an atom is empty space. (ii) Almost entire mass and entire positive charge is concentrated in a very small region called nucleus. At distance of closest approach $E_k = E_P$ $K = \frac{1}{4\pi\varepsilon_0}\frac{(Ze).(2e)}{d}$ $d = \frac{1}{4\pi\varepsilon_0}\frac{(2Ze^2)}{K}$	½ ½ ½ ½	**3**
25	Finding the current in the branch BM in the network. 3		
	Finding equivalent resistance across CH , R_{CH} = 2R Equivalent circuit diagram	½	
		½	
	In closed loop ABMNA $-3IR - 4I_1R + 16E = 0$ ……(1) In closed loop BCHMB $-2R(I-I_1) - 6E + 4I_1R = 0$ ……..(2)	½ ½	

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	On solving equations (1) and (2) $I_1 = \frac{25E}{13R}$	1	**3**
26	Finding value of current in a long straight wire — 2 ½ Finding direction of current in a long straight wire — ½ Magnetic field due to circular current loop at its centre O. $B_1 = \frac{\mu_0 I_1}{2r}$ $= \frac{\mu_0 \times 1}{2 \times 0.1}$ $= 5\mu_0 T$ The magnetic field B_1 is perpendicular to plane of loop and directed inwards. Magnetic field due to long current carrying straight wire at O. $B_2 = \frac{\mu_0 I_2}{2\pi r}$ $B_2 = \frac{\mu_0 I_2}{2\pi \times 0.2}$ T For net magnetic field at O to be zero, B_1 should be equal and opposite to B_2. $5\mu_0 = \frac{\mu_0 I_2}{0.4\pi}$ $I_2 = 2\pi$ A $= 6.28$ A Direction of current in the straight wire is along +ve x axis. **Alternatively** Net magnetic field at O is zero. $B_{loop} = B_{wire}$ $\frac{\mu_0 I_1}{2r_1} = \frac{\mu_0 I_2}{2\pi r_2}$ $\frac{\mu_0 \times 1}{2 \times 0.1} = \frac{\mu_0 I_2}{2\pi \times 0.2}$ $I_2 = 2\pi$ A $= 6.28$ A Direction of current is along + x-axis.	½ ½ ½ ½ ½ ½ ½ 1 ½ ½ ½	**3**
27	Naming the electromagnetic waves — 1 ½ Writing range of electromagnetic waves — 1 ½ (i) Radio waves — wavelength range > 0.1 m — ½ + ½ (ii) X- rays — wavelength range 1nm – 10^{-3} nm — ½ + ½ (iii) Infrared waves — wavelength range 1mm - 700 nm — ½ + ½		**3**

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28 (a)

(i) Defining mutual inductance	½
SI unit of mutual inductance	½
(ii) Deriving expression for mutual inductance	2

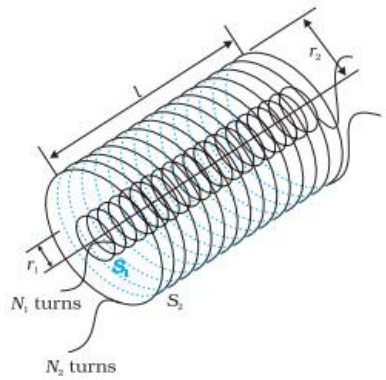
(i) Mutual inductance between two coils is defined as the magnetic flux associated with a coil when unit current flows through neighbouring coil. ½

Alternatively

Mutual inductance between two coils is defined as the magnitude of induced emf in a coil when the rate of change of current in neighbouring coil is unity.

SI unit of mutual inductance is henry(H). ½

(ii)



When current I_2 flows in outer solenoid, the resulting flux linkage with inner solenoid.

$N_1\phi_1 = N_1B_2A_1$ ½

$N_1\phi_1 = N_1\left(\frac{\mu_0 N_2 I_2}{l}\right)\pi r_1^2$

$N_1\phi_1 = \frac{\mu_0 N_1 N_2 \pi r_1^2 I_2}{l}$ .....(1) ½

$N_1\phi_1 = M_{12}I_2$ ..... (2) ½

From equations (1) and (2)

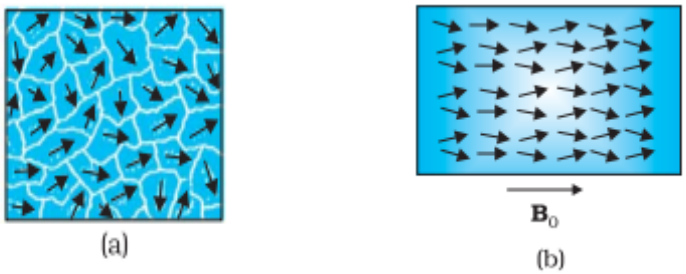
$M_{12} = \frac{\mu_0 N_1 N_2 \pi r_1^2}{l}$ ½ **3**

OR

(b)

Defining ferromagnetic materials	1
Explanation of ferromagnetism with diagram	2

Ferromagnetic substances are those which get strongly magnetised when placed in an external magnetic field. 1



(a) (b) ½ + ½

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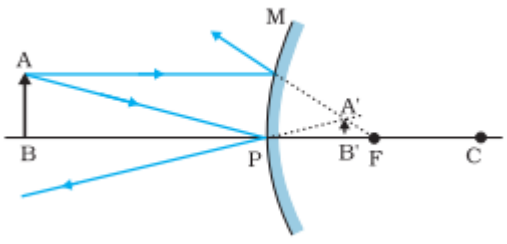
	In absence of external magnetic field, domains are randomly oriented and it exhibits weak magnetisation. In the presence of external magnetic field domains orient themselves in the direction of magnetic field and it exhibits strong magnetisation.	½ ½	
	SECTION - D		
29	(i) (B) 0.01 eV (ii) (D) 5×10^{22} m^{-3} (iii) (a) (C) Electrons diffuse from n-region into p-region and holes diffuse from p-region to n-region. OR (b) (A) Diffusion current is large and drift current is small. (iv) (D) 50 Hz , 100 Hz.	1 1 1 1	**4**
30	(i) (B) $\frac{-5}{3}D$ (ii) (C) $\frac{3}{2}$ (iii) (A) increases when a lens is dipped in water. (iv) (a) (B) 10 cm , right from lens. OR (b) (A) real , 24 cm	1 1 1 1	**4**
	SECTION - E		
31	a) i) Drawing of ray diagram 1 Obtaining mirror equation 2 ii) Reason for using multi-component lenses 1 iii) Finding magnification produced by the objective 1		
	i) 	1	
	For paraxial rays MP can be considered to be a straight line perpendicular to CP, Therefore right angled triangles $A'B'F$ and MPF are similar $\frac{B'A'}{PM} = \frac{B'F}{FP}$ Or $\frac{B'A'}{BA} = \frac{B'F}{FP}$ ($\because$ PM = AB) ----------(1) Since $\angle$ APB = $\angle$ $A'PB'$, the right angled triangles $A'PB'$ and ABP are also similar	½	

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Therefore , $\frac{B'A'}{BA} = \frac{B'P}{BP}$ ---------- (2) ½

Comparing eq (1) and (2), we get

$$\frac{B'F}{FP} = \frac{B'P}{BP}$$

$$\frac{PF - PB'}{FP} = \frac{B'P}{BP}$$

Using sign convention

$PF = f,\ PB' = +v\ ,\ PB = -u$ ½

on solving $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ ½

ii) To improve image quality by minimizing various optical aberrations in lenses. 1

iii) Magnification produced by compound microscope

$$m = m_o \times m_e$$ ½

$$m_o = \frac{m}{m_e} = \frac{m}{\left|\frac{D}{fe}\right|}$$

$$m_o = \frac{200}{\frac{25}{2}} = 16$$ ½ **5**

OR

(b)

i) Difference between a wavefront and a ray	1
ii) Statement of Huygens' principle	1
Verification of the law of reflection	1 ½
iii) Finding wavelength of light	1 ½

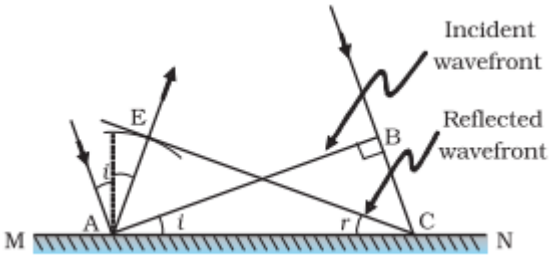
i) Wavefront is a surface of constant phase. ½

Alternatively Locus of points, which oscillate in phase

Ray - The straight line path along which light travels (or energy propagates). ½

Alternatively – Ray is normal to wave front.

ii) **Huygens' Principle** Each point of the wave front is the source of secondary disturbance and the wavelets emanating from the points spread out in all directions with speed of wave. The wavelets emanating from wave front are usually referred to as secondary wavelets. A common tangent to all these spheres gives the new position of the wave front at a later time. 1



1

Triangles EAC and BAC are congruent therefore $\angle i = \angle r$ ½

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iii) Position of 4^{th} bright fringe

$$x_{4(bright)} = 4\frac{D\lambda}{d}$$ ½

Position of 2^{nd} dark fringe

$$x_{2(dark)} = \frac{3}{2}\frac{D\lambda}{d}$$ ½

$$x_{4(bright)} - x_{2(dark)} = 5mm$$

$$4\frac{D\lambda}{d} - \frac{3}{2}\frac{D\lambda}{d} = 5\times10^{-3}$$

$$\lambda = 6\times10^{-6}\ m$$ ½

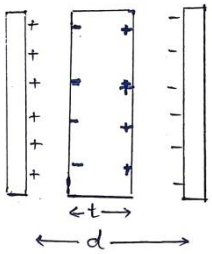
32

(i) Obtaining expression for capacitance	3
(ii) Finding capacitance of capacitors	2

a) (i)

Electric field in air between plates

$$E_0 = \frac{\sigma}{\varepsilon_0}$$ ½



Electric field inside the dielectric

$$E = \frac{\sigma}{\varepsilon_0 K}$$ ½

Potential difference between the plates

$$V = E_0(d-t) + Et$$ ½

$$V = \frac{\sigma}{\varepsilon_0}\left[d-t+\frac{t}{K}\right]$$

$$V = \frac{q}{A\varepsilon_0}\left[d-t+\frac{t}{K}\right]$$ ½

Capacitance

$$C = \frac{q}{V}$$ ½

$$C = \frac{A\varepsilon_0}{d-t+\frac{t}{K}}$$

$$C = \frac{A\varepsilon_0}{d-t\left(1-\frac{1}{K}\right)}$$ ½

ii) Total energy stored in series combination

$$\frac{1}{2}\left(\frac{C_1C_2}{C_1+C_2}\right)V^2 = 40\times10^{-3}\ J \quad \ldots\ldots(1)$$ ½

Energy stored in parallel combination

$$\frac{1}{2}(C_1+C_2)V^2 = 250\times10^{-3}\ J \quad \ldots\ldots(2)$$ ½

Substituting value of V=100 V in eq (1) and (2) , on solving

$C_1 = 4\times10^{-5}$ F or $40\,\mu F$ ½

$C_2 = 1\times10^{-5}$ F or $10\,\mu F$ ½ **5**

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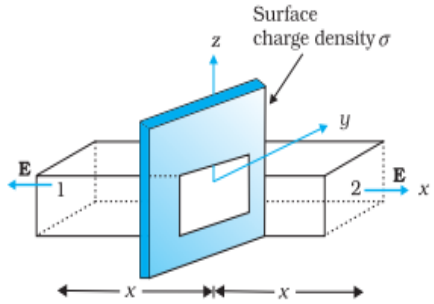
OR

b)

i) Showing electric field at a point due to a uniformly charged infinite plane sheet		3
ii) Calculating	(1) electric flux through the cube	1
	(2) charge enclosed by cube	1

(i)



1

$\oint \vec{E}.d\vec{s} = \int_1 \vec{E}.d\vec{s} + \int_2 \vec{E}.d\vec{s}$ ½

$= 2EA$

From Gauss's law

$\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$ ½

$2EA = \frac{\sigma A}{\varepsilon_0}$

$E = \frac{\sigma}{2\varepsilon_0}$ ½

Vectorially $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ ½

Electric field is normally outward of the sheet.

(ii)

(1) Electric flux through the cube

$\phi = \phi_L + \phi_R$ ½

$\phi = \int \vec{E}_L.d\vec{s} + \int \vec{E}_R.d\vec{s}$

$= -2\times100\times10^{-4} + [5\times(10\times10^{-2})^2 + 2]\times100\times10^{-4}$

$\phi = 5\times10^{-4}\ Nm^2C^{-1}$ ½

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(2)

$$\phi = \frac{q_{en}}{\varepsilon_0}$$ ½

$$q_{en} = \phi.\varepsilon_0$$

$$= 5 \times 10^{-4} \times 8.85 \times 10^{-12}$$

$$= 4.43 \times 10^{-15} \text{C}$$ ½

33 (a)

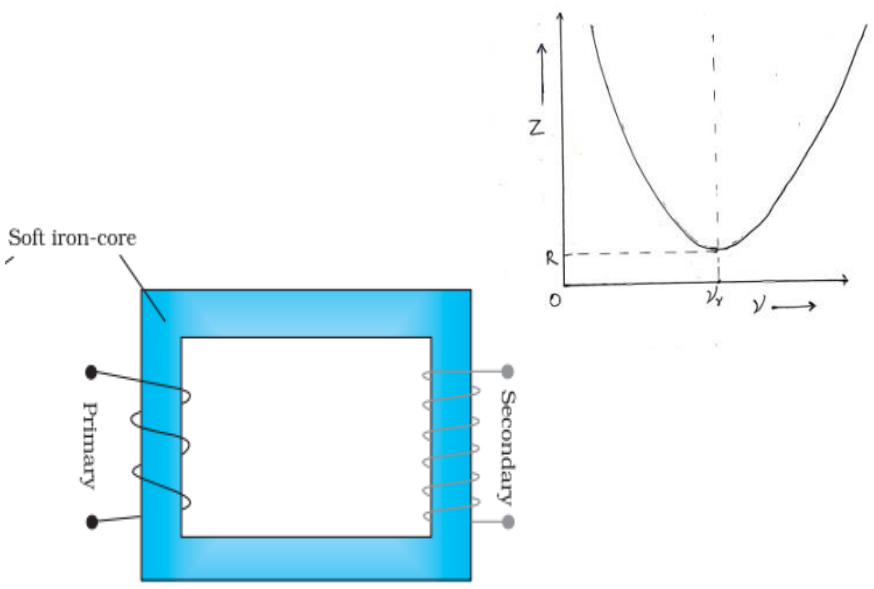
(i) Factors on which the resonant frequency of a series LCR circuit depends	1
Plotting of graph	1
(ii) Diagram of a transformer	1
Working of a step-up transformer	1
(iii) Two causes of energy loss in a real transformer	1

(i) Inductance ½
Capacitance ½

Alternatively

$$\nu_0 = \frac{1}{2\pi\sqrt{LC}}$$

(ii)



1

Working - when an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it. 1

(iii) Causes of energy loss (any two) ½ + ½

(1) Flux leakage
(2) Resistance of the windings
(3) Hysteresis
(4) Eddy currents

OR

(b)

(i) Diagram of ac generator	1
Brief explanation of construction and working of ac generator	2
(ii) Obtaining expression of magnetic moment associated with revolving electron	2

5

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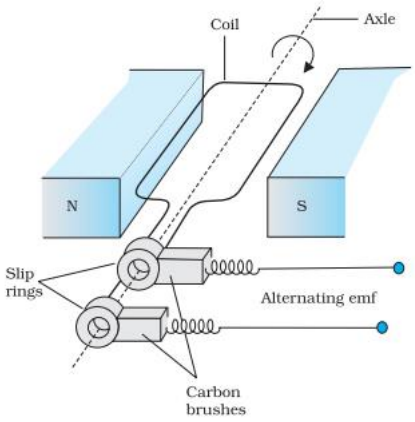
(i)



1

Construction – It consists of a coil placed in a magnetic field. The coil is mounted on a rotor shaft. The ends of the coil are connected to an external circuit by means of slip rings and brushes. 1

Alternatively

If a student draws only a labeled diagram of ac generator give 2 marks for construction and diagram.

Working – The coil is rotated in the uniform magnetic field by some external means. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. 1

Alternatively

If a student derives $e = e_0 \sin \omega t$ give one mark for working.

(ii) The equivalent current

$$I = \frac{q}{t} = \frac{e}{\frac{2\pi r}{v}} = \frac{ev}{2\pi r}$$ ½

Mangetic moment of revolving electron

$m = IA$ ½

$$= \frac{ev}{2\pi r} \times \pi r^2$$ ½

$$= \frac{1}{2} evr$$ ½

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Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT PHYSICS (CODE 55/4/2)

General Instructions: -

1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and

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	encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 to 70 (example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

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MARKING SCHEME : PHYSICS (042)			
CODE : 55/4/2			
Q.NO	VALUE POINTS/EXPECTED ANSWERS	MARKS	TOTAL MARKS
SECTION - A			
1	(A) $\frac{11}{48}\frac{q}{\pi\varepsilon_0 L}$	1	1
2	(D) $q_3 > q_1 > q_2$	1	1
3	(A) Small and negative .	1	1
4	(A) R	1	1
5	(C) Helical path.	1	1
6	(A) There is a minimum frequency of incident radiation below which no electrons are emitted.	1	1
7	(A) Zero	1	1
8	(C) $r_n \alpha n^2$	1	1
9	(B) 20 mA	1	1
10	(B) 1 mA	1	1
11	(D) Close together and weaker in intensity.	1	1
12	No option is correct, award 1 mark.	1	1
13	(C) Assertion (A) is true and Reason (R) is false.	1	1
14	(A) Both assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion(A).	1	1
15	(D) Both Assertion (A) and Reason (R) are false.	1	1
16	(B) Both assertion (A) and Reason (R) are true and Reason (R)is not the correct explanation of Assertion(A).	1	1
SECTION – B			
17	(a) Finding nature and position of image 2 Using refraction formula at spherical surface from denser to rarer medium n_1 = refractive index of rarer medium n_2 = refractive index of denser medium $\frac{n_1}{v} - \frac{n_2}{u} = \frac{n_1 - n_2}{R}$ u = - 20 cm , R= - 40 cm , n_1 = 1 , n_2 = 1.5 $\frac{1}{v} - \frac{1.5}{(-20)} = \frac{1-1.5}{(-40)}$ v = -16 cm Nature of image is virtual. OR (b) Finding the focal lengths of the objective and eyepiece 2 Distance between objective and eyepiece fo + fe = 1.00 m = 100 cm Magnifying power $\lvert m \rvert = \frac{fo}{fe} = 19$ On solving fo = 95 cm = 0.95 m fe = 5 cm = 0.05 m	½ ½ ½ ½ ½ ½ ½	**2**

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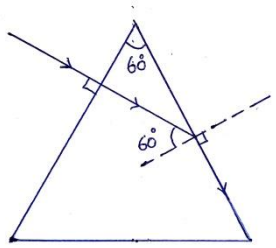
18	Defining matter waves 1 Arranging de Broglie wavelength in increasing order 1 The waves associated with every moving particle are called matter waves. $\lambda = \frac{h}{\sqrt{2mK}}$ For same kinetic energy , $\lambda \ \alpha \ \frac{1}{\sqrt{m}}$ $m_\alpha > m_p > m_e$ $\therefore \ \lambda_\alpha < \lambda_p < \lambda_e$	1 ½ ½	**2**
19	Finding refractive index of the medium 2  From snell's law, $\mu.\sin i = \mu_m.\sin r$ $\mu.\sin 60^0 = \mu_m.\sin 90^0$ $\mu_m = \mu.\frac{\sqrt{3}}{2}$ **<u>Alternatively</u>** $\mu = \frac{1}{\sin C}$ $\frac{\mu}{\mu_m} = \frac{1}{\sin 60^0}$ $\mu_m = \frac{\sqrt{3}}{2}\mu$	½ ½ ½ 1 ½ ½	**2**
20	(i) Finding resistance $\left(\frac{R_A}{R_B}\right)$ 1 (ii) Finding resistivity $\left(\frac{\sigma_A}{\sigma_B}\right)$ 1 (i) Slope of *I-V* graph = $\left(\frac{\Delta I}{\Delta V}\right) = \frac{I}{R}$	½	

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$$\frac{R_A}{R_B} = \frac{\text{Slope of B}}{\text{Slope of A}}$$

$$= \frac{\tan 45^0}{\tan 30^0}$$

$$\frac{R_A}{R_B} = \sqrt{3}$$ ½

(ii)

$$\frac{\sigma_A}{\sigma_B} = \frac{R_A \frac{A_A}{l_A}}{R_B \frac{A_B}{l_B}}$$ ½

$$= \frac{R_A}{R_B} \cdot \frac{A_A}{A_B} \cdot \frac{l_B}{l_A}$$

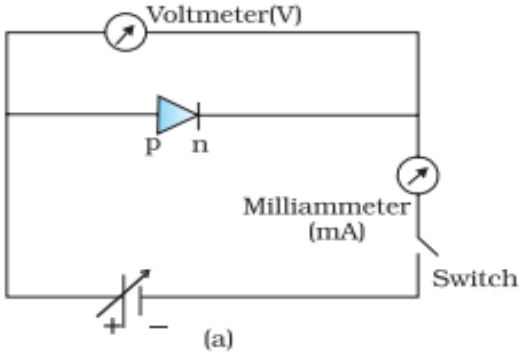
$$= \sqrt{3} \times \frac{4}{1} \times \frac{2}{1}$$

$$= 8\sqrt{3}$$ ½ **2**

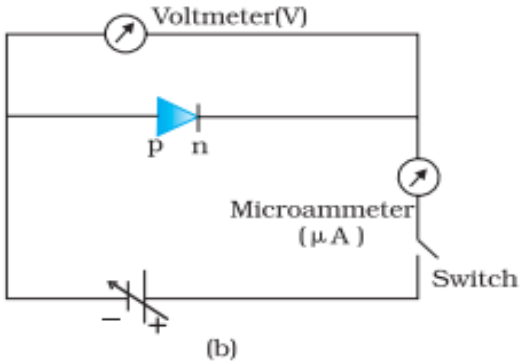
21

Drawing of circuit diagram of p-n junction diode	
(i) Forward bias	½
(ii) Reverse bias	½
I-V charcteristics in forward and reverse bias	½ + ½

(i)



(a)



(b)

½

½

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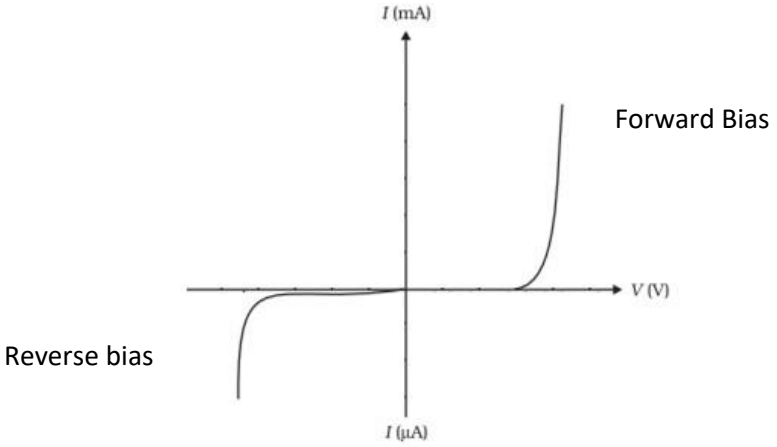
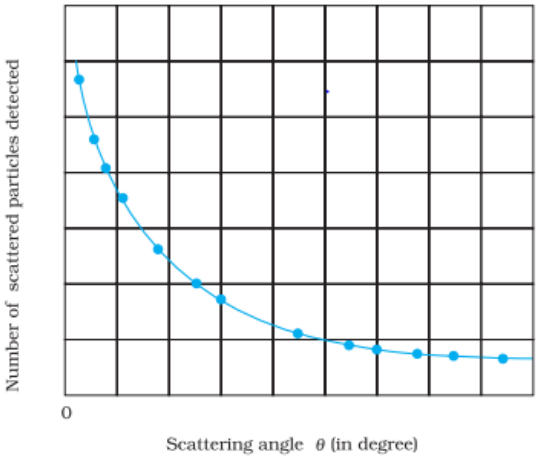
	I-V characteristics in forward and reverse bias  	½ + ½	**2**
	SECTION – C		
22	Drawing graph showing variation of scattered particles detected(N) with scattering angle(θ) 1 Two conclusions 1 Obtaining expression for the distance of closest approach 1  Two conclusions (i) Most of an atom is empty space. (ii) Almost entire mass and entire positive charge is concentrated in a very small region called nucleus. At distance of closest approach $E_k = E_P$ $K = \frac{1}{4\pi\varepsilon_0}\frac{(Ze).(2e)}{d}$ $d = \frac{1}{4\pi\varepsilon_0}\frac{(2Ze^2)}{K}$	1 ½ ½ ½ ½	**3**
23	(i) Finding charge density on outer surface of shell 1 ½ (ii) Finding the potential at a distance of (R/2) from the centre of the shell 1 ½		

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	(i) When a point charge Q is placed at the centre of the shell, a charge (–Q) is induced at its inner surface, consequently a net charge on outer surface of the shell = q + Q Charge density on outer surface of the shell $\sigma = \frac{charge}{Area}$ $= \frac{q+Q}{4\pi R^2}$ (ii) Potential due to shell at a distance of (R/2) from the centre of the shell $V_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}$ Potential due to charge Q at a distance of (R/2) from the centre of the shell $V_2 = \frac{1}{4\pi\varepsilon_0}.\frac{Q}{R/2}$ Net potential at a distance of (R/2) from the centre of the shell $V = V_2 + V_2$ $V = \frac{1}{4\pi\varepsilon_0 R}(q+2Q)$	1 ½ ½ ½ ½	**3**
24	(a) Difference between nuclear fission and fusion (1) (b) Calculating energy released in fission (2) (a) In nuclear fission , a heavy nucleus splits into two or more lighter nuclei and energy is released. In nuclear fusion, lighter nuclei combine together a form a heavy nucleus and larger amount of energy is released. (b) Number of atoms in 1 g of $_{94}Pu^{239}$ $= \frac{6.023\times10^{23}}{239}$ $= 2.5\times10^{21}$ Energy released in fission of 1 g of $_{94}Pu^{239}$, $E = 180MeV\times2.5\times10^{21}$ $E = 4.5\times10^{23}$ MeV	½ ½ 1 1	**3**
25	Finding magnitude and direction of the net magnetic field at point P_1 1 ½ Finding magnitude and direction of the net magnetic field at point P_2 1 ½ Net magnetic field at point P_1 $B = B_{y(wire)} - B_{x(wire)}$ $= \frac{\mu_0 I_1}{2\pi r} - \frac{\mu_0 I_2}{2\pi r}$ $= \frac{\mu_0}{2\pi\times2}(5-3)$ $B = 2\times10^{-7}$ T	½ ½	

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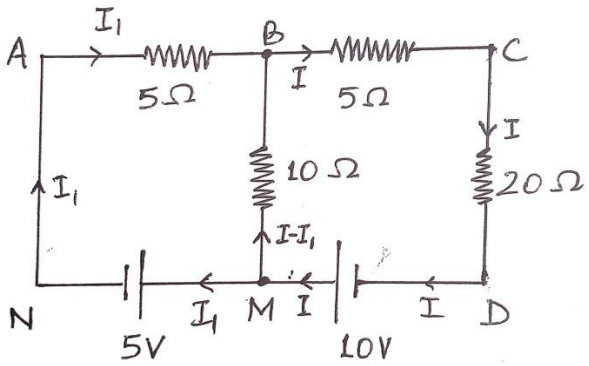
	The direction of net magnetic field is along –ve z-axis. Net magnetic field at point P_2 $B = B_{y(wire)} + B_{x(wire)}$ $= \frac{\mu_0 I_1}{2\pi r} + \frac{\mu_0 I_2}{2\pi r}$ $= \frac{4\mu_0}{2\pi \times 1}(5+3)$ $= \frac{4\mu_0}{\pi}$ $= 16\times10^{-7}$ T The direction of net magnetic field is along +ve z-axis.	½ ½ ½ ½	**3**
26	Defining displacement current 1 Difference between Displacement current and conduction current 1 Justification of the continuity of current in the circuit 1 Displacemnt current is the current which arises due to rate of change of electric field. Displacement current is due to varying electric field. Conduction current is due to motion of electrons in the presence of electric field . When the capacitor is being charged by a source of emf , the electric field between the plates of capacitor changes with time. It produces a displacement current i_d whose magnitude is equal to conduction current i_c. Therefore the current is continious in the circuit.	1 ½ ½ 1	**3**
27	Finding current in the arm AB 1 ½ Finding current in the arm BC 1 ½ Circuit diagram with distribution of current  Using Kirchhoff's voltage rule In closed loop ABMNA, $-5I_1 + 10(I - I_1) - 5 = 0$ ..... (1) In closed loop ACDNA $-5I - 20I + 10 - 5 - 5I_1 = 0$ ..... (2)	1 ½ ½	

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Solving eq (1) and (2)

$$I_1 = -\frac{3}{17}\ A \text{ and } I = \frac{4}{17}$$

Magnitude of current in arm AB = $\frac{3}{17}$ A ½

Magnitude of current in arm BC = $\frac{4}{17}$ A ½ **3**

28 (a)

(i) Defining mutual inductance	½
SI unit of mutual inductance	½
(ii) Deriving expression for mutual inductance	2

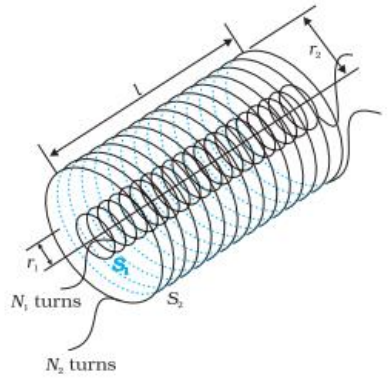
(i) Mutual inductance between two coils is defined as the magnetic flux associated with a coil when unit current flows through neighbouring coil. ½

Alternatively

Mutual inductance between two coils is defined as the magnitude of induced emf in a coil when the rate of change of current in neighbouring coil is unity.

SI unit of mutual inductance is henry(H). ½

(ii)



When current I_2 flows in outer solenoid, the resulting flux linkage with inner solenoid.

$N_1\phi_1 = N_1B_2A_1$ ½

$N_1\phi_1 = N_1\left(\frac{\mu_0 N_2 I_2}{l}\right)\pi r_1^2$

$N_1\phi_1 = \frac{\mu_0 N_1 N_2 \pi r_1^2 I_2}{l}$ .....(1) ½

$N_1\phi_1 = M_{12} I_2$ ..... (2) ½

From equations (1) and (2)

$M_{12} = \frac{\mu_0 N_1 N_2 \pi r_1^2}{l}$ ½ **3**

OR

(b)

Defining ferromagnetic materials	1
Explanation of ferromagnetism with diagram	2

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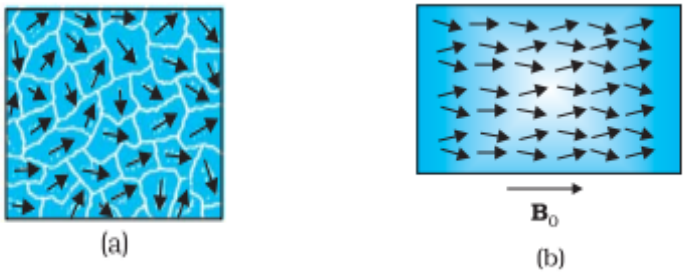
	Ferromagnetic substances are those which get strongly magnetised when placed in an external magnetic field.  (a) (b) In absence of external magnetic field, domains are randomly oriented and it exhibits weak magnetisation. In the presence of external magnetic field domains orient themselves in the direction of magnetic field and it exhibits strong magnetisation.	1 ½ + ½ ½ ½	
	SECTION - D		
29	(i) (B) $\frac{-5}{3}D$ (ii) (C) $\frac{3}{2}$ (iii) (A) increases when a lens is dipped in water. (iv) (a) (B) 10 cm , right from lens. OR (b) (A) real , 24 cm	1 1 1 1	**4**
30	(i) (B) 0.01 eV (ii) (D) 5×10^{22} m^{-3} (iii) (a) (C) Electrons diffuse from n-region into p-region and holes diffuse from p-region to n-region. OR (b) (A) Diffusion current is large and drift current is small. (iv) (D) 50 Hz , 100 Hz.	1 1 1 1	**4**
	SECTION - E		
31	(a) (i) Factors on which the resonant frequency of a series LCR circuit depends 1 Plotting of graph 1 (ii) Diagram of a transformer 1 Working of a step-up transformer 1 (iii) Two causes of energy loss in a real transformer 1 (i) Inductance Capacitance	 ½ ½	

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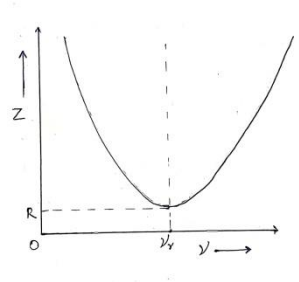
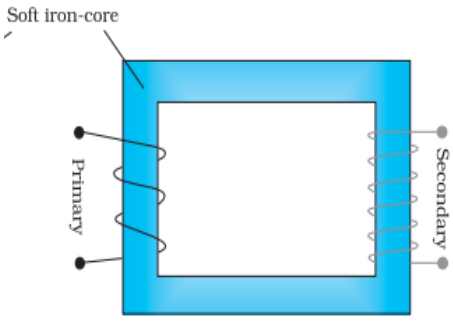
Alternatively

$$\nu_0 = \frac{1}{2\pi\sqrt{LC}}$$



1

(ii)



1

Working - when an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it.

1

(iii) Causes of energy loss (any two)

(1) Flux leakage
(2) Resistance of the windings
(3) Hysteresis
(4) Eddy currents

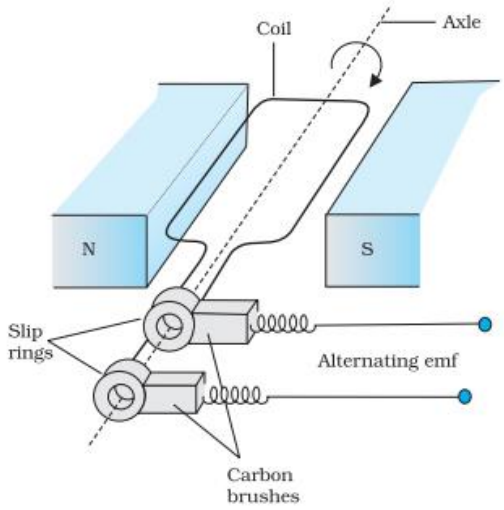
½ + ½ **5**

OR

(b)

(i) Diagram of ac generator	1
Brief explanation of construction and working of ac generator	2
(ii) Obtaining expression of magnetic moment associated with revolving electron	2

(i)



1

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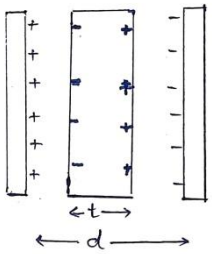
	Construction – It consists of a coil placed in a magnetic field. The coil is mounted on a rotor shaft. The ends of the coil are connected to an external circuit by means of slip rings and brushes. **Alternatively** If a student draws only a labeled diagram of ac generator give 2 marks for construction and diagram. **Working** – The coil is rotated in the uniform magnetic field by some external means. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. **Alternatively** If a student derives $e = e_0 \sin \omega t$ give one mark for working. (ii) The equivalent current $I = \frac{q}{t} = \frac{e}{\frac{2\pi r}{v}} = \frac{ev}{2\pi r}$ Mangetic moment of revolving electron $m = IA$ $= \frac{ev}{2\pi r} \times \pi r^2$ $= \frac{1}{2} evr$	1 1 ½ ½ ½ ½	
32	a) (i) Obtaining expression for capacitance 3 (ii) Finding capacitance of capacitors 2 a) (i) Electric field in air between plates $E_0 = \frac{\sigma}{\varepsilon_0}$ Electric field inside the dielectric $E = \frac{\sigma}{\varepsilon_0 K}$ Potential difference between the plates $V = E_0(d-t) + Et$ $V = \frac{\sigma}{\varepsilon_0}\left[d - t + \frac{t}{K}\right]$ $V = \frac{q}{A\varepsilon_0}\left[d - t + \frac{t}{K}\right]$ Capacitance $C = \frac{q}{V}$ $C = \frac{A\varepsilon_0}{d - t + \frac{t}{K}}$ $C = \frac{A\varepsilon_0}{d - t\left(1 - \frac{1}{K}\right)}$	 ½ ½ ½ ½ ½	

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ii) Total energy stored in series combination

$$\frac{1}{2}\left(\frac{C_1C_2}{C_1+C_2}\right)V^2 = 40\times10^{-3}\ J \text{.....(1)}$$ ½

Energy stored in parallel combination

$$\frac{1}{2}(C_1+C_2)V^2 = 250\times10^{-3}\ J \text{.....(2)}$$ ½

Substituting value of V=100 V in eq (1) and (2) , on solving

$C_1 = 4\times10^{-5}$ F or $40\,\mu F$ ½

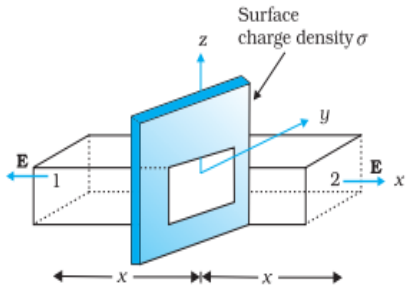
$C_2 = 1\times10^{-5}$ F or $10\,\mu F$ ½ **5**

OR

b)

i) Showing electric field at a point due to a uniformly charged infinite plane sheet		3
ii) Calculating	(1) electric flux through the cube	1
	(2) charge enclosed by cube	1

(i)



1

$$\oint \vec{E}.d\vec{s} = \int_1 \vec{E}.d\vec{s} + \int_2 \vec{E}.d\vec{s}$$ ½

$$= 2EA$$

From Gauss's law

$$\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$$ ½

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

$$E = \frac{\sigma}{2\varepsilon_0}$$ ½

Vectorially $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ ½

Electric field is normally outward of the sheet.

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(ii)

(1) Electric flux through the cube

$$\phi = \phi_L + \phi_R$$ ½

$$\phi = \int \vec{E}_L . d\vec{s} + \int \vec{E}_R . d\vec{s}$$

$$= -2\times100\times10^{-4} + [5\times(10\times10^{-2})^2 + 2]\times100\times10^{-4}$$

$$\phi = 5\times10^{-4}\ \text{Nm}^2\text{C}^{-1}$$ ½

(2)

$$\phi = \frac{q_{en}}{\varepsilon_0}$$ ½

$$q_{en} = \phi.\varepsilon_0$$

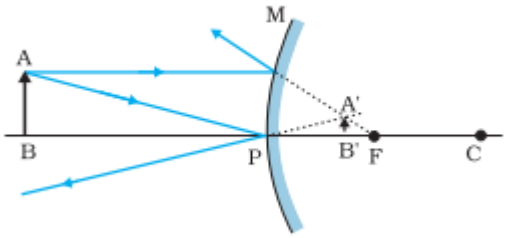
$$= 5\times10^{-4}\times8.85\times10^{-12}$$

$$= 4.43\times10^{-15}\text{C}$$ ½

33

a)	i) Drawing of ray diagram	1
	Obtaining mirror equation	2
	ii) Reason for using multi-component lenses	1
	iii) Finding magnification produced by the objective	1

i)



1

For paraxial rays MP can be considered to be a straight line perpendicular to CP,

Therefore right angled triangles $A'B'F$ and MPF are similar

$$\frac{B'A'}{PM} = \frac{B'F}{FP}$$

Or $\frac{B'A'}{BA} = \frac{B'F}{FP}$ ($\because$ PM = AB) ----------(1) ½

Since $\angle$ APB = $\angle$ $A'PB'$, the right angled triangles $A'PB'$ and ABP are also similar

Therefore , $\frac{B'A'}{BA} = \frac{B'P}{BP}$ ---------- (2) ½

Comparing eq (1) and (2), we get

$$\frac{B'F}{FP} = \frac{B'P}{BP}$$

$$\frac{PF - PB'}{FP} = \frac{B'P}{BP}$$

Using sign convention

PF = f, PB' = +v , PB = -u ½

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on solving $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ ½

ii) To improve image quality by minimizing various optical aberrations in lenses. 1

iii) Magnification produced by compound microscope

$m = m_o \times m_e$ ½

$m_o = \frac{m}{m_e} = \frac{m}{\left|\frac{D}{fe}\right|}$

$m_o = \frac{200}{\frac{25}{2}} = 16$ ½ **5**

OR

(b)

i) Difference between a wavefront and a ray	1
ii) Statement of Huygens' principle	1
Verification of the law of reflection	1 ½
iii) Finding wavelength of light	1 ½

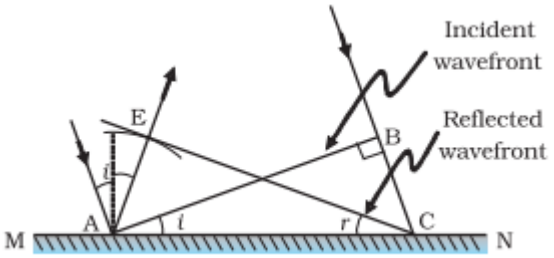
i) Wavefront is a surface of constant phase. ½

Alternatively Locus of points, which oscillate in phase

Ray - The straight line path along which light travels (or energy propagates). ½

Alternatively – Ray is normal to wave front.

ii) **Huygens' Principle** Each point of the wave front is the source of secondary disturbance and the wavelets emanating from the points spread out in all directions with speed of wave. The wavelets emanating from wave front are usually referred to as secondary wavelets. A common tangent to all these spheres gives the new position of the wave front at a later time. 1



1

Triangles EAC and BAC are congruent therefore $\angle i = \angle r$ ½

iii) Position of 4th bright fringe

$x_{4(bright)} = 4\frac{D\lambda}{d}$ ½

Position of 2nd dark fringe

$x_{2(dark)} = \frac{3}{2}\frac{D\lambda}{d}$ ½

$x_{4(bright)} - x_{2(dark)} = 5mm$

$4\frac{D\lambda}{d} - \frac{3}{2}\frac{D\lambda}{d} = 5\times10^{-3}$

$\lambda = 6\times10^{-6}$ m ½

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Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT PHYSICS (CODE 55/4/3)

General Instructions: -

1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and

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	encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 to 70_(example 0 to 80/70/60/50/40/30 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the "**Guidelines for Spot Evaluation**" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

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MARKING SCHEME : PHYSICS (042)			
CODE : 55/4/3			
Q.NO	VALUE POINTS/EXPECTED ANSWERS	MARKS	TOTAL MARKS
SECTION - A			
1	(A) 2 pE	1	1
2	(B) Repulsive and $\frac{q\lambda}{2\pi\varepsilon_0 x}$	1	1
3	(A) Zero.	1	1
4	(D) Closer together and weaker in intensity.	1	1
5	No option is correct, award 1 mark.	1	1
6	No option is correct, award 1 mark.	1	1
7	(A) R	1	1
8	(B) 1mA	1	1
9	(C) $\frac{1}{\sqrt{2}}\sqrt{\left(i_1^2+i_2^2\right)}$	1	1
10	(A) There is a minimum frequency of incident radiation below which no electrons are emitted.	1	1
11	(A) Small and negative.	1	1
12	(C) $r_n \alpha\ n^2$	1	1
13	(A) Both assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion(A).	1	1
14	(C) Assertion (A) is true and Reason (R) is false.	1	1
15	(B) Both assertion (A) and Reason (R) are true and Reason (R)is not the correct explanation of Assertion(A).	1	1
16	(D) Both Assertion (A) and Reason (R) are false.	1	1
SECTION – B			
17	(a) Finding nature and position of image 2 Using refraction formula at spherical surface from denser to rarer medium n_1 = refractive index of rarer medium n_2 = refractive index of denser medium $\frac{n_1}{v}-\frac{n_2}{u}=\frac{n_1-n_2}{R}$ u = - 20 cm , R= - 40 cm , n_1 = 1 , n_2 = 1.5 $\frac{1}{v}-\frac{1.5}{(-20)}=\frac{1-1.5}{(-40)}$ v = -16 cm Nature of image is virtual. OR (b) Finding the focal lengths of the objective and eyepiece 2 Distance between objective and eyepiece fo + fe = 1.00 m = 100 cm Magnifying power $\lvert m\rvert=\frac{fo}{fe}=19$ On solving fo = 95 cm = 0.95 m fe = 5 cm = 0.05 m	½ ½ ½ ½ ½ ½ ½	**2**

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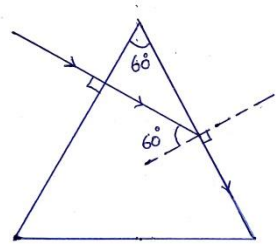
18	Finding $\frac{V_p}{V_d}$ 2 De Broglie wavelength of proton $\lambda_p = \frac{h}{\sqrt{2meV_p}}$ De Broglie wavelength of deutron $\lambda_d = \frac{h}{\sqrt{2(2m)eV_d}}$ $\frac{\lambda_p}{\lambda_d} = \frac{1}{2} = \frac{\sqrt{2(2m)eV_d}}{\sqrt{2meV_p}}$ On solving $\frac{V_p}{V_d} = 8$	½ ½ ½ ½	**2**
19	Finding refractive index of the medium 2  From snell's law, $\mu.\sin i = \mu_m.\sin r$ $\mu.\sin 60^0 = \mu_m.\sin 90^0$ $\mu_m = \mu.\frac{\sqrt{3}}{2}$ **Alternatively** $\mu_{ga} = \frac{1}{\sin C}$ $\frac{\mu}{\mu_m} = \frac{1}{\sin 60^0}$ $\mu_m = \frac{\sqrt{3}}{2}\mu$	½ ½ ½ ½ 1 ½ ½	**2**
20	Finding temperature of conductor 2 $R_2 = R_1 + 25\%\text{of } R_1 = 1.25R_1$ Temperature coefficient of resistance $\alpha = \frac{R_2 - R_1}{R_1.\Delta T}$ $T_2 - 27 = \frac{1.25R_1 - R_1}{R_1 \times 2\times 10^{-4}}$ $T_2 = 1277\ ^0C$	½ ½ ½ ½	**2**

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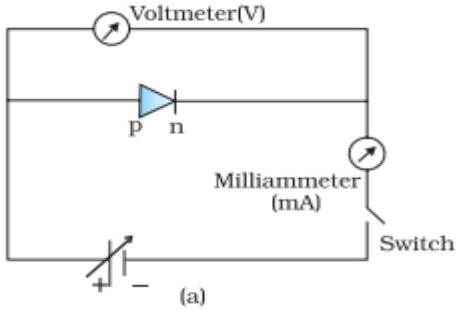
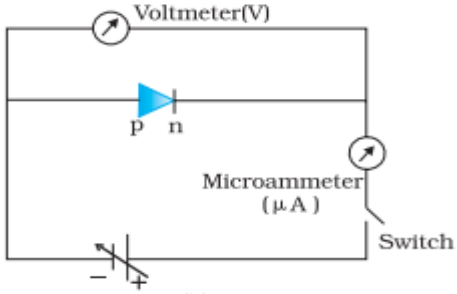
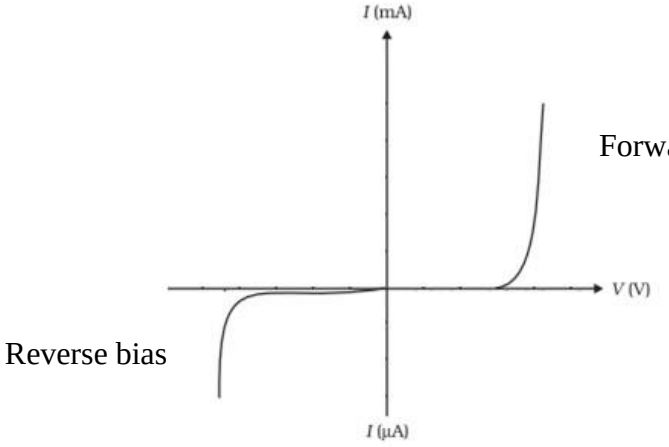
21	Drawing of circuit diagram of p-n junction diode (i) Forward bias ½ (ii) Reverse bias ½ I-V charcteristics in forward and reverse bias ½ + ½ (i)  (a)  (b) I-V characteristics in forward and reverse bias  	½ ½ ½ + ½	**2**
	SECTION - C		
22	(a) (i) Defining mutual inductance ½ SI unit of mutual inductance ½ (ii) Deriving expression for mutual inductance 2 (i) Mutual inductance between two coils is defined as the magnetic flux associated with a coil when unit current flows through neighbouring coil. **Alternatively** Mutual inductance between two coils is defined as the magnitude of induced emf in a coil when the rate of change of current in neighbouring coil is unity. SI unit of mutual inductance is henry(H).	½ ½	

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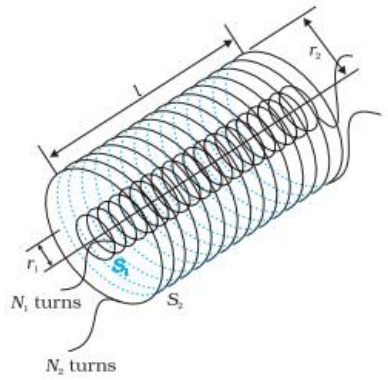
(ii)



When current I_2 flows in outer solenoid, the resulting flux linkage with inner solenoid.

$N_1\phi_1 = N_1B_2A_1$ ½

$N_1\phi_1 = N_1\left(\frac{\mu_0 N_2 I_2}{l}\right)\pi r_1^2$

$N_1\phi_1 = \frac{\mu_0 N_1 N_2 \pi r_1^2 I_2}{l}$ .....(1) ½

$N_1\phi_1 = M_{12}I_2$ ..... (2) ½

From equations (1) and (2)

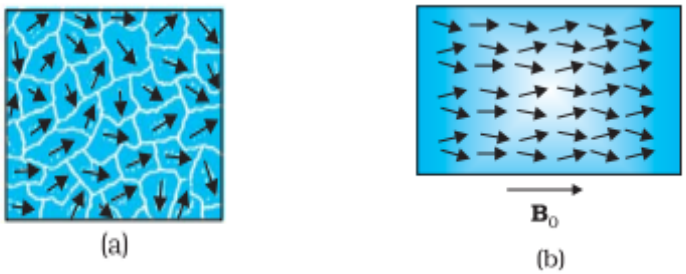
$M_{12} = \frac{\mu_0 N_1 N_2 \pi r_1^2}{l}$ ½ **3**

OR

(b)

Defining ferromagnetic materials	1
Explanation of ferromagnetism with diagram	2

Ferromagnetic substances are those which get strongly magnetised when placed in an external magnetic field. 1



½ + ½

In absence of external magnetic field, domains are randomly oriented and it exhibits weak magnetisation. ½

In the presence of external magnetic field domains orient themselves in the direction of magnetic field and it exhibits strong magnetisation. ½

23

Finding expression for final potential of shell A	3

Charge on spherical Shell A

$q_A = 4\pi R^2\sigma$ ½

Charge on speherical shell B

$q_B = 4\pi(2R)^2\sigma = 16\pi R^2\sigma$ ½

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After connecting by a wire , their potentials will become equal after sharing of charge.

$$\frac{1}{4\pi\varepsilon_0}\frac{q'_A}{R} = \frac{1}{4\pi\varepsilon_0}\frac{q'_B}{2R}$$ ½

$$q'_B = 2q'_A$$

From conservation of charge

$$q_A + q_B = q'_A + q'_B$$ ½

$$4\pi R^2\sigma + 16\pi R^2\sigma = 3q'_A$$

$$q'_A = \frac{20\pi R^2\sigma}{3}$$ ½

Final potential of Shell A

$$V_A = \frac{1}{4\pi\varepsilon_0}\frac{q'_A}{R}$$

$$V_A = \frac{1}{4\pi\varepsilon_0}\frac{20\pi R^2\sigma}{3R}$$

$$V_A = \frac{5\sigma R}{3\varepsilon_0}$$ ½ **3**

Alternatively

Charge on spherical shell A

$q_A = 4\pi R^2\sigma$ ½

Charge on spherical shell B

$q_B = 4\pi(2R)^2\sigma = 16\pi R^2\sigma$ ½

After connecting by a wire , their potential will become equal after sharing of charges ½

Therefore the potential of shell A

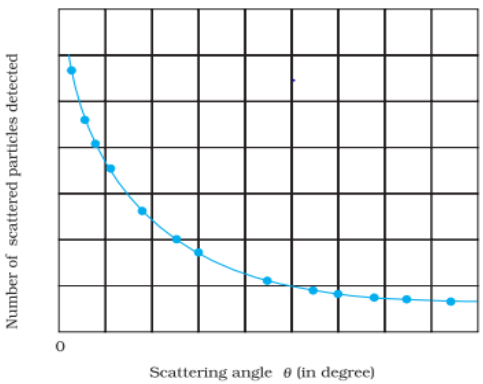
$$V_A = V_{common} = \frac{q_A + q_B}{C_A + C_B}$$ ½

$$= \frac{4\pi R^2\sigma + 16\pi R^2\sigma}{4\pi\varepsilon_0 R + 4\pi\varepsilon_0(2R)}$$ ½

$$= \frac{5\sigma R}{3\varepsilon_0}$$ ½

24

Drawing graph showing variation of scattered particles detected (N) with scattering angle(θ)	1
Two conclusions	1
Obtaining expression for the distance of closest approach	1



1

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	Two conclusions (i) Most of an atom is empty space. (ii) Almost entire mass and entire positive charge is concentrated in a very small region called nucleus. At distance of closest approach $E_k = E_P$ $K = \frac{1}{4\pi\varepsilon_0}\frac{(Ze).(2e)}{d}$ $d = \frac{1}{4\pi\varepsilon_0}\frac{(2Ze^2)}{K}$	½ ½ ½ ½	**3**
25	(i) Calculating effective resistance 2 (ii) Calculating power supplied by battery 1 i) $R_{ABC} = 10+10 = 20\,\Omega$ Equivalent resistance across AC $R_{AC} = \frac{20\times20}{20+20} = 10\Omega$ Equivalent resistance across AD $R_{AD} = \frac{20\times20}{20+20} = 10\ \Omega$ Equivalent resistance across AM $R_{AM} = \frac{20\times30}{20+30} = 12\,\Omega$ ii) Net resistance of circuit $R_{net} = 12+10+8 = 30\ \Omega$ Power supplied $P = \frac{V^2}{R_{net}}$ $= \frac{(6)^2}{30}$ $= 1.2$ W **Alternatively** Net resistance of circuit $R_{net} = 12+10+8 = 30\ \Omega$ $I = \frac{\varepsilon}{R_{net}}$ $= \frac{6}{30}$ $= 0.2$ A	½ ½ ½ ½ ½ ½ ½	**3**

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	Power supplied $P = VI$ $= 6 \times 0.2$ $= 1.2\,W$	½	
26	Finding magnitude of force 2 ½ Finding direction of force ½ Magnetic field at P due to infinite straight conductor carrying current $\vec{B} = \frac{\mu_0 I}{2\pi r}\hat{k}$ Force on charge q in this magnetic field $\vec{F} = q(\vec{v} \times \vec{B})$ $\vec{F} = q\left[(v_0\,\hat{j}) \times \left(\frac{\mu_0 I}{2\pi r}\right)\hat{k}\right]$ $\vec{F} = \frac{\mu_0 q v_0 I}{2\pi r}\hat{i}$ The magnitude of force $F = \frac{\mu_0 q v_0 I}{2\pi r}$ The direction of force on charge is along +ve X-axis.	½ ½ ½ ½ ½ ½	**3**
27	Reasons for i) Difference in mode of interaction of electromagnetic wave with matter 1 ii) Containing water in food items to be heated in microwave 1 iii) Wearing facemask with glasses by welders during welding 1 (i) Since they have different wavelenghts and frequencies, they differ considerably in their mode of interaction with matter. (ii) Frequency of microwave matches with the resonant frequency of water molecules so that energy from wave is transferred to water molecules. (iii) To protect their eyes from large amount of ultraviolet rays produced by welding arcs.	1 1 1	**3**
28	(a) Difference between nuclear fission and fusion (1) (b) Calculating energy released in fission (2) (a) In nuclear fission , a heavy nucleus splits into two or more lighter nuclei and energy is released. In nuclear fusion, lighter nuclei combine together a form a heavy nucleus and larger amount of energy is released. (b) Number of atoms in 1 g of $_{94}Pu^{239}$ $= \frac{6.023 \times 10^{23}}{239}$ $= 2.5 \times 10^{21}$	½ ½ 1	

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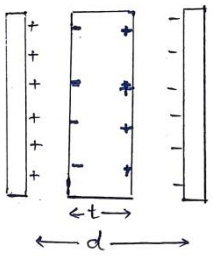
	Energy released in fission of 1 g of $_{94}Pu^{239}$, $E = 180MeV \times 2.5 \times 10^{21}$ $E = 4.5 \times 10^{23}$ MeV	1	**3**
	SECTION - D		
29	(i) (B) 0.01 eV (ii) (D) 5×10^{22} m^{-3} (iii) (a) (C) Electrons diffuse from n-region into p-region and holes diffuse from p-region to n-region. OR (b) (A) Diffusion current is large and drift current is small. (iv) (D) 50 Hz , 100 Hz.	1 1 1 1	 **4**
30	(i) (B) $\frac{-5}{3}D$ (ii) (C) $\frac{3}{2}$ (iii) (A) increases when a lens is dipped in water. (iv) (a) (B) 10 cm , right from lens. OR (b) (A) real , 24 cm	1 1 1 1 	 **4**
	SECTION - E		
31	a) (i) Obtaining expression for capacitance 3 (ii) Finding capacitance of capacitors 2 a) (i) Electric field in air between plates $E_0 = \frac{\sigma}{\varepsilon_0}$ Electric field inside the dielectric $E = \frac{\sigma}{\varepsilon_0 K}$ Potential difference between the plates $V = E_0(d-t) + Et$ $V = \frac{\sigma}{\varepsilon_0}\left[d-t+\frac{t}{K}\right]$ $V = \frac{q}{A\varepsilon_0}\left[d-t+\frac{t}{K}\right]$ Capacitance $C = \frac{q}{V}$ $C = \frac{A\varepsilon_0}{d-t+\frac{t}{K}}$	 ½ ½ ½ ½ ½	

$$C=\frac{A\varepsilon_0}{d-t\left(1-\frac{1}{K}\right)}$$ ½

ii) Total energy stored in series combination

$$\frac{1}{2}\left(\frac{C_1C_2}{C_1+C_2}\right)V^2 = 40\times10^{-3}\,J \text{.....(1)}$$ ½

Energy stored in parallel combination

$$\frac{1}{2}(C_1+C_2)V^2=250\times10^{-3}\,J \text{.....(2)}$$ ½

Substituting value of V=100 V in eq (1) and (2) , on solving

$C_1=4\times10^{-5}$ F or $40\,\mu F$ ½

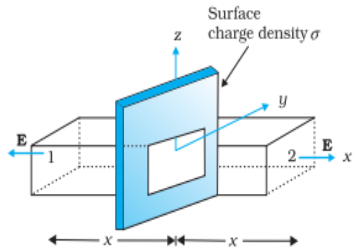
$C_2=1\times10^{-5}$ F or $10\,\mu F$ ½ **5**

OR

b)

i) Showing electric field at a point due to a uniformly charged infinite plane sheet		3
ii) Calculating	(1) electric flux through the cube	1
	(2) charge enclosed by cube	1

(i)



1

$$\oint \vec{E}.d\vec{s} = \int_1 \vec{E}.d\vec{s} + \int_2 \vec{E}.d\vec{s}$$ ½

$$=2EA$$

From Gauss's law

$$\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$$ ½

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

$$E = \frac{\sigma}{2\varepsilon_0}$$ ½

Vectorially $\vec{E}=\frac{\sigma}{2\varepsilon_0}\hat{n}$ ½

Electric field is normally outward of the sheet.

(ii) (1) Electric flux through the cube ½

$$\phi = \phi_L + \phi_R$$

$$\phi = \int \vec{E}_L.d\vec{s} + \int \vec{E}_R.d\vec{s}$$

$$= -2\times100\times10^{-4} + [5\times(10\times10^{-2})^2+2]\times100\times10^{-4}$$

$$\phi = 5\times10^{-4}\ Nm^2C^{-1}$$ ½

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(2)

$$\phi = \frac{q_{en}}{\varepsilon_0}$$

$$q_{en} = \phi.\varepsilon_0$$

$$= 5 \times 10^{-4} \times 8.85 \times 10^{-12}$$

$$= 4.43 \times 10^{-15} \text{C}$$

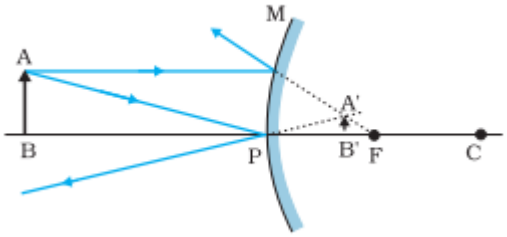
½

½

32

a) i) Drawing of ray diagram		1
Obtaining mirror equation		2
ii) Reason for using multi-component lenses		1
iii) Finding magnification produced by the objective		1

i)



1

For paraxial rays MP can be considered to be a straight line perpendicular to CP,
Therefore right angled triangles $A'B'F$ and MPF are similar

$$\frac{B'A'}{PM} = \frac{B'F}{FP}$$

Or $\frac{B'A'}{BA} = \frac{B'F}{FP}$ ($\because$ PM = AB) ----------(1)

½

Since $\angle$ APB = $\angle$ $A'PB'$, the right angled triangles $A'PB'$ and ABP are also similar

Therefore , $\frac{B'A'}{BA} = \frac{B'P}{BP}$ ---------- (2)

½

Comparing eq (1) and (2), we get

$$\frac{B'F}{FP} = \frac{B'P}{BP}$$

$$\frac{PF - PB'}{FP} = \frac{B'P}{BP}$$

Using sign convention

PF = f, PB' = +v , PB = -u

½

on solving $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

½

ii) To improve image quality by minimizing various optical aberrations in lenses.

1

iii) Magnification produced by compound microscope

½

$$m = m_o \times m_e$$

$$m_o = \frac{m}{m_e} = \frac{m}{\left|\frac{D}{fe}\right|}$$

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$$m_o = \frac{200}{\frac{25}{2}} = 16$$ ½ **5**

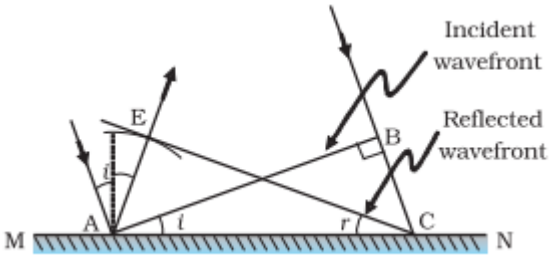
OR

(b)

i) Difference between a wavefront and a ray	1
ii) Statement of Huygens' principle	1
Verification of the law of reflection	1 ½
iii) Finding wavelength of light	1 ½

i) Wavefront is a surface of constant phase. ½
Alternatively Locus of points, which oscillate in phase
Ray - The straight line path along which light travels (or energy propagates). ½
Alternatively – Ray is normal to wave front.

ii) **Huygens' Principle** Each point of the wave front is the source of secondary disturbance and the wavelets emanating from the points spread out in all directions with speed of wave. The wavelets emanating from wave front are usually referred to as secondary wavelets. A common tangent to all these spheres gives the new position of the wave front at a later time. 1



Triangles EAC and BAC are congruent therefore $\angle i = \angle r$ 1

iii) Position of 4th bright fringe

$$x_{4(bright)} = 4\frac{D\lambda}{d}$$ ½

Position of 2nd dark fringe

$$x_{2(dark)} = \frac{3}{2}\frac{D\lambda}{d}$$ ½

$$x_{4(bright)} - x_{2(dark)} = 5mm$$

$$4\frac{D\lambda}{d} - \frac{3}{2}\frac{D\lambda}{d} = 5\times10^{-3}$$

$\lambda = 6\times10^{-6}$ m ½

33 (a)

(i) Factors on which the resonant frequency of a series LCR circuit depends	1
Plotting of graph	1
(ii) Diagram of a transformer	1
Working of a step-up transformer	1
(iii) Two causes of energy loss in a real transformer	1

(i) Inductance ½
Capacitance ½

Alternatively

$$\nu_0 = \frac{1}{2\pi\sqrt{LC}}$$

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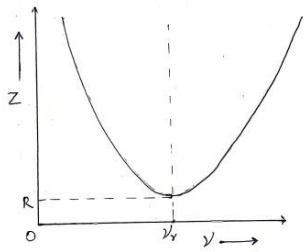
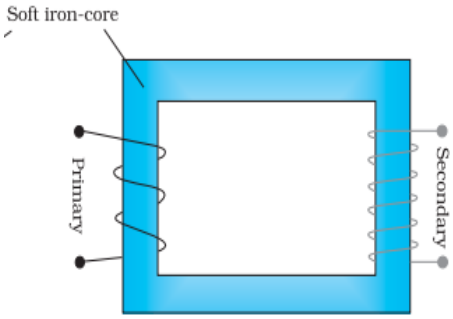


1

(ii)



1

Working - when an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it.

1

(iii) Causes of energy loss (any two)

(1) Flux leakage
(2) Resistance of the windings
(3) Hysteresis
(4) Eddy currents

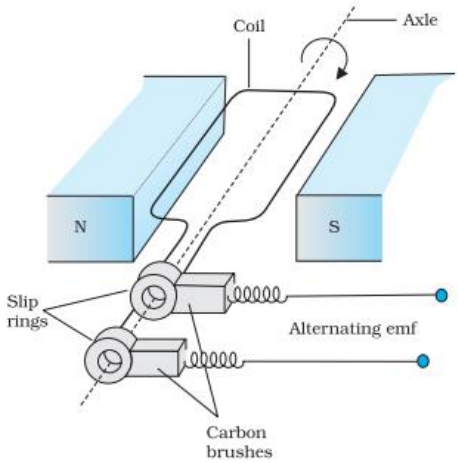
½ + ½ | **5**

OR

(b)

(i) Diagram of ac generator	1
Brief explanation of construction and working of ac generator	2
(ii) Obtaining expression of magnetic moment associated with revolving electron	2

(i)



1

<u>Construction</u> – It consists of a coil placed in a magnetic field. The coil is mounted on a rotor shaft. The ends of the coil are connected to an external circuit by means of slip rings and brushes.

1

<u>Alternatively</u>

If a student draws only a labeled diagram of ac generator give 2 marks for construction and diagram.

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	Working – The coil is rotated in the uniform magnetic field by some external means. The rotation of the coil causes the magnetic flux through it to change, so an emf is induced in the coil. **Alternatively** If a student derives $e = e_0 \sin \omega t$ give one mark for working. (ii) The equivalent current $I = \frac{q}{t} = \frac{e}{\frac{2\pi r}{v}} = \frac{ev}{2\pi r}$ Mangetic moment of revolving electron m = IA $= \frac{ev}{2\pi r} \times \pi r^2$ $= \frac{1}{2} evr$	1 ½ ½ ½ ½	

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