Set-3

Series SR5QP/5

प्रश्न-पत्र कोड
Q.P. Code **55/5/3**

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.

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*** *में प्रश्न संख्या* ***1*** *से* ***16*** *तक बहुविकल्पीय प्रकार के* ***एक-एक*** *अंक के प्रश्न हैं।*

(iv) ***खण्ड – ख*** *में प्रश्न संख्या* ***17*** *से* ***21*** *तक अति लघु-उत्तरीय प्रकार के* ***दो-दो*** *अंकों के प्रश्न हैं।*

(v) ***खण्ड – ग*** *में प्रश्न संख्या* ***22*** *से* ***28*** *तक लघु-उत्तरीय प्रकार के* ***तीन-तीन*** *अंकों के प्रश्न हैं।*

(vi) ***खण्ड – घ*** *में प्रश्न संख्या* ***29*** *एवं* ***30*** *दीर्घ-उत्तरीय प्रकार के* ***चार-चार*** *अंकों के प्रश्न हैं।*

(vii) ***खण्ड – ङ*** *में प्रश्न संख्या* ***31*** *से* ***33*** *केस-आधारित* ***पाँच-पाँच*** *अंकों के प्रश्न हैं।*

(viii) *प्रश्न-पत्र में समग्र विकल्प नहीं दिया गया है। यद्यपि, खण्ड-**ख** के **1** प्रश्न में, खण्ड-**ग** के **1** प्रश्न में, खण्ड-**घ** के **2** प्रश्नों में तथा खण्ड-**ङ** के **3** प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है।*

(ix) *कैल्कुलेटर का उपयोग वर्जित है।*

$c = 3 \times 10^8$ 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}

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) *In* ***Section A :*** *Question number* ***1*** *to* ***16*** *are Multiple Choice (MCQ) type questions carrying* ***1*** *mark each.*

(iv) *In* ***Section B :*** *Question number* ***17*** *to* ***21*** *are Very Short Answer (VSA) type questions carrying* ***2*** *marks each.*

(v) *In* ***Section C :*** *Question number* ***22*** *to* ***28*** *are Short Answer (SA) type questions carrying* ***3*** *marks each.*

(vi) *In* ***Section D :*** *Question number* ***29*** *&* ***30*** *are Long Answer (LA) type questions carrying* ***4*** *marks each.*

(vii) *In* ***Section E :*** *Question number* ***31*** *to* ***33*** *are Case-Based questions carrying* ***5*** *marks each.*

(viii) *There is no overall choice. However, an internal choice has been provided in* ***1*** *question in Section–****B****,* ***1*** *question in Section–****C****,* ***2*** *questions in Section–****D*** *and* ***3*** *questions in Section–****E****.*

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

$c = 3 \times 10^8$ 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}

खण्ड – क

1. अनुमतांक (P, V) की किसी तापीय–कुण्डली को दो समान भागों में काटा गया और फिर एक भाग को V वोल्ट की बैटरी से संयोजित किया गया । इसके द्वारा उपभुक्त शक्ति होगी

(A) P (B) $\frac{P}{2}$

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

2. दो विद्युतरोधी आवरण युक्त संकेन्द्री कुण्डलियाँ जिनमें प्रत्येक की त्रिज्या R है एक दूसरे के लम्बवत् स्थित हैं । इनमें से एक में धारा I और दूसरी में $\sqrt{3}$ I धारा प्रवाहित हो रही है । इनके उभयनिष्ठ केन्द्र पर नेट चुम्बकीय क्षेत्र का परिमाण होगा –

(A) $\frac{\mu_0 I}{R}$ (B) $\frac{\mu_0 I}{2R}$

(C) $\frac{\mu_0 I}{4R}$ (D) $\frac{2\mu_0 I}{R}$

3. नीचे दिए गए किस एक पदार्थ की चुम्बकीय प्रवृत्ति, x का परिसर $0 < x < \varepsilon$ है, जहाँ ε धनात्मक और लघु है ?

(A) एल्युमिनियम (B) पानी

(C) गैडोलिनियम (D) बिस्मथ

4. 100 Ω प्रतिरोध का कोई गैल्वेनोमीटर 1.0 mA धारा के लिए पूर्ण पैमाना विक्षेपण दर्शाता है । इसे (0 – 1A) परिसर के एमीटर में परिवर्तित किया गया है । इस एमीटर का प्रतिरोध (निकटतम) है –

(A) 0.1 Ω (B) 0.8 Ω

(C) 1.0 Ω (D) 10 Ω

5. किसी दिए गए अभिविन्यास में दो कुण्डलियों का अन्योन्य प्रेरण 50 mH है । यदि किसी एक कुण्डली में धारा में परिवर्तन $i = 1.0 \sin\left(100\ \pi t + \frac{\pi}{3}\right)$ A के रूप में होता है, तो अन्य कुण्डली में प्रेरित विद्युत वाहक बल (emf) (वोल्ट में) का शिखर मान होगा –

(A) $\frac{\pi}{5}$ (B) 5π

(C) 0.5π (D) 0.05π

SECTION – A

1. A heater coil rated as (P, V) is cut into two equal parts. One of the parts is then connected to a battery of V volt. The power consumed by it will be

(A) P (B) $\frac{P}{2}$

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

2. Two insulated concentric coils, each of radius R, placed at right angles to each other, carry currents I and $\sqrt{3}$ I respectively. The magnitude of the net magnetic field at their common centre will be

(A) $\frac{\mu_o I}{R}$ (B) $\frac{\mu_o I}{2R}$

(C) $\frac{\mu_o I}{4R}$ (D) $\frac{2\mu_o I}{R}$

3. Which of the following material has its magnetic susceptibility x in the range $0 < x < \varepsilon$, where ε is positive and small ?

(A) Aluminium (B) Water

(C) Gadolinium (D) Bismuth

4. A galvanometer of resistance 100 Ω gives full scale deflection for a current of 1.0 mA. It is converted into an ammeter of range (0 – 1A). The resistance of the ammeter will be close to

(A) 0.1 Ω (B) 0.8 Ω

(C) 1.0 Ω (D) 10 Ω

5. The mutual inductance of two coils, in a given orientation is 50 mH. If the current in one of the coils changes as $i = 1.0 \sin\left(100\,\pi t + \frac{\pi}{3}\right)$ A, the peak value of emf (in volt) induced in the other coil will be

(A) $\frac{\pi}{5}$ (B) 5π

(C) 0.5π (D) 0.05π

6. किसी नाभिक के भीतर दो न्यूक्लिऑनों के बीच लगभग कितनी दूरी पर स्थितिज ऊर्जा निम्नतम होती है ?

(A) 0.8 fm (B) 1.6 fm

(C) 2.0 fm (D) 2.8 fm

7. 5×10^{28} परमाणु प्रति घनमीटर के शुद्ध Si क्रिस्टल का मादन 1 ppm सांद्रता के एन्टीमनी के साथ किया गया है । यदि मादित क्रिस्टल में विवरों की सांद्रता $4.5 \times 10^{9}\ m^{-3}$ पायी जाती है तो Si क्रिस्टल में नैज़ आवेश वाहकों की सांद्रता (m^{-3} में) होती है लगभग

(A) 1.2×10^{15} (B) 1.5×10^{16}

(C) 3.0×10^{15} (D) 2.0×10^{16}

8. हाइड्रोजन परमाणु की निम्नतम अवस्था में किसी इलेक्ट्रॉन की ऊर्जा –13.6 eV है । प्रथम उत्तेजित अवस्था में इस इलेक्ट्रॉन की गतिज ऊर्जा और स्थितिज ऊर्जा होगी –

(A) –13.6 eV, 27.2 eV (B) –6.8 eV, 13.6 eV

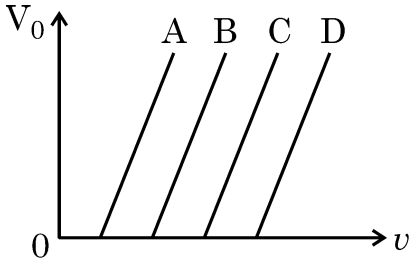
(C) 3.4 eV, –6.8 eV (D) 6.8 eV, –3.4 eV

9. जल के शोधन में प्रयोग की जाने वाली विद्युतचुम्बकीय तरंगें होती हैं –

(A) अवरक्त किरणें (B) पराबैंगनी किरणें

(C) X-किरणें (D) गामा किरणें

10. चार धातुओं A, B, C और D के लिए आपतित विकिरणों की आवृत्ति (υ) के साथ निरोधी विभव (V_0) के विचरण को आरेख में दर्शाया गया है । सभी धातुओं में फोटोइलेक्ट्रॉन उत्पन्न करने के लिए, आपतित विकिरणों की समान आवृत्ति के लिए अधिकतम गतिज ऊर्जा वाले फोटोइलेक्ट्रॉन वाली धातु है



(A) A (B) B

(C) C (D) D

6. The potential energy between two nucleons inside a nucleus is minimum at a distance of about

(A) 0.8 fm (B) 1.6 fm

(C) 2.0 fm (D) 2.8 fm

7. A pure Si crystal having 5×10^{28} atoms m^{-3} is dopped with 1 ppm concentration of antimony. If the concentration of holes in the doped crystal is found to be 4.5×10^{9} m^{-3}, the concentration (in m^{-3}) of intrinsic charge carriers in Si crystal is about

(A) 1.2×10^{15} (B) 1.5×10^{16}

(C) 3.0×10^{15} (D) 2.0×10^{16}

8. The energy of an electron in the ground state of hydrogen atom is –13.6 eV. The kinetic and potential energy of the electron in the first excited state will be

(A) –13.6 eV, 27.2 eV (B) –6.8 eV, 13.6 eV

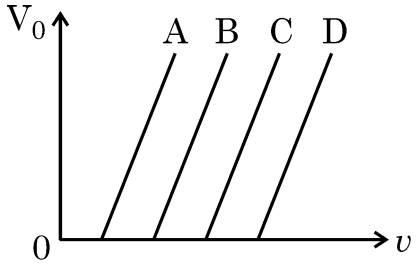
(C) 3.4 eV, –6.8 eV (D) 6.8 eV, –3.4 eV

9. The electromagnetic waves used to purify water are

(A) Infrared rays (B) Ultraviolet rays

(C) X-rays (D) Gamma rays

10. The variation of the stopping potential (V_0) with the frequency (υ) of the incident radiation for four metals A, B, C and D is shown in the figure. For the same frequency of incident radiation producing photo-electrons in all metals, the kinetic energy of photo-electrons will be maximum for metal



(A) A (B) B

(C) C (D) D

11. किसी संयुक्त सूक्ष्मदर्शी के अभिदृश्यक और नेत्रिका की फोकस दूरी क्रमश: 1 cm और 2 cm हैं । यदि इस सूक्ष्मदर्शी की नलिका की लम्बाई 10 cm है, तो सरलतम शिथिल नेत्रों से देखने के लिए इस सूक्ष्मदर्शी से प्राप्त आवर्धन है

(A) 250 (B) 200

(C) 150 (D) 125

12. कोई बिन्दुकित बिम्ब 40 cm वक्रता त्रिज्या के किसी गोलीय उत्तल पृष्ठ (अपवर्तनांक, n = 1.5) के सामने 60 cm दूरी पर स्थित है । बनने वाला प्रतिबिम्ब

(A) वास्तविक होगा और पृष्ठ से 1.8 m दूरी पर बनेगा ।

(B) आभासी होगा और पृष्ठ से 1.8 m दूरी पर बनेगा ।

(C) वास्तविक होगा और पृष्ठ से 3.6 m दूरी पर बनेगा ।

(D) आभासी होगा और पृष्ठ से 3.6 m दूरी पर बनेगा ।

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 गए कोड **(A)**, **(B)**, **(C)** और **(D)** में से चयन कीजिए :

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

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

(C) यदि अभिकथन (A) सत्य है परन्तु कारण (R) असत्य है ।

(D) यदि अभिकथन (A) असत्य है और कारण (R) भी असत्य है ।

13. **अभिकथन (A) :** यंग के द्वि-झिरी प्रयोग में जब दो कला संबद्ध स्रोत परस्पर अत्यणु दूरी पर होते हैं, तो व्यतिकरण पैटर्न का प्रेक्षण नहीं किया जा सकता है ।

कारण (R) : फ्रिंज चौड़ाई दो स्रोतों के बीच पृथकन के अनुक्रमानुपाती होती है ।

14. **अभिकथन (A) :** कोई एल्फा-कण किसी गोल्ड-नाभिक की ओर गतिमान है । 180° के कोण पर प्रकीर्णन के लिए संघट्ट प्राचल अधिकतम होता है ।

कारण (R) : किसी एल्फा-कण प्रकीर्णन प्रयोग में संघट्ट प्राचल लक्ष्य नाभिक की परमाणु संख्या पर निर्भर नहीं करता है ।

11. The focal lengths of the objective and the eyepiece of a compound microscope are 1 cm and 2 cm respectively. If the tube length of the microscope is 10 cm, the magnification obtained by the microscope for most suitable viewing by relaxed eye is :

(A) 250 (B) 200

(C) 150 (D) 125

12. A point object is kept 60 cm in front of a spherical convex surface (n = 1.5, radius of curvature 40 cm). The image formed is

(A) real, at a distance 1.8 m from the surface.

(B) virtual, at a distance 1.8 m from the surface.

(C) real, at a distance 3.6 m from the surface.

(D) virtual, at a distance 3.6 m from the surface.

For Questions **13** to **16**, two statements are given – one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

(A) If both Assertion (A) and Reason (R) are true and Reason (R) is 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 but Reason (R) is false.

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

13. **Assertion (A)** : In a Young's double-slit experiment, interference pattern is not observed when two coherent sources are infinitely close to each other.

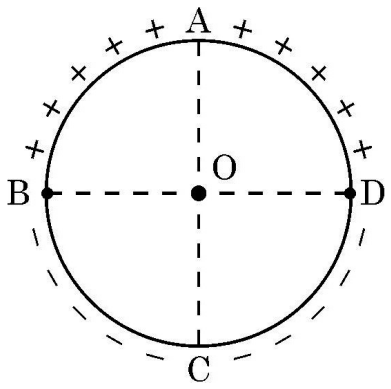
Reason (R) : The fringe width is proportional to the separation between the two sources.

14. **Assertion (A)** : An alpha particle is moving towards a gold nucleus. The impact parameter is maximum for the scattering angle of 180°.

Reason (R) : The impact parameter in an alpha particle scattering experiment does not depend upon the atomic number of the target nucleus.

15. **अभिकथन (A) :** आरेख में दर्शाए अनुसार किसी पतले वृत्ताकार वलय के दो अर्ध भागों पर समान मात्रा में धनावेश और ऋणावेश एकसमान वितरित हैं । इस वलय के केन्द्र O पर परिणामी विद्युत क्षेत्र OC के अनुदिश होता है ।

कारण (R) : इसका कारण यह है कि O पर नेट विभव शून्य नहीं है ।



16. **अभिकथन (A) :** किसी चुम्बकीय क्षेत्र में गतिमान किसी आवेशित कण की ऊर्जा परिवर्तित नहीं होती है ।

कारण (R) : इसका कारण यह है चुम्बकीय क्षेत्र में गतिमान किसी आवेश पर चुम्बकीय बल द्वारा किया गया कार्य शून्य होता है ।

खण्ड – ख

17. किसी बाह्य चुम्बकीय क्षेत्र $\vec{B}$ में स्थित लम्बाई L के किसी सीधे चालक, जिससे धारा I प्रवाहित हो रही है, पर कार्यरत चुम्बकीय बल $\vec{F}$ के लिए व्यंजक व्युत्पन्न कीजिए । यदि यह चालक टेढ़ी-मेढ़ी आकृति में हो, तो भी क्या यह व्यंजक वैध होगा ? पुष्टि कीजिए ।

18. (a) 30 cm भुजा के किसी वर्ग के चार शीर्षों A, B, C और D पर 1 μC, –2 μC, 1 μC और –2 μC के चार बिन्दु आवेश क्रमश: स्थित हैं । इस वर्ग के केन्द्र पर स्थित 4 μC के आवेश पर कार्यरत नेट बल ज्ञात कीजिए ।

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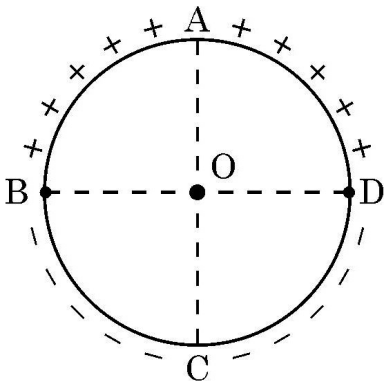
18. (b) 10 cm भुजा के किसी समबाहु त्रिभुज के प्रत्येक शीर्ष पर 1 pC का बिन्दु आवेश स्थित है । इस त्रिभुज के केन्द्रक पर नेट विद्युत क्षेत्र ज्ञात कीजिए ।

15. **Assertion (A)** : Equal amount of positive and negative charges are distributed uniformly on two halves of a thin circular ring as shown in figure. The resultant electric field at the centre O of the ring is along OC.

Reason (R) : It is so because the net potential at O is not zero.



16. **Assertion (A)** : The energy of a charged particle moving in a magnetic field does not change.

Reason (R) : It is because the work done by the magnetic force on the charge moving in a magnetic field is zero.

SECTION – B

17. Derive an expression for magnetic force $\vec{F}$ acting on a straight conductor of length L carrying current I in an external magnetic field $\vec{B}$. Is it valid when the conductor is in zig-zag form ? Justify.

18. (a) Four point charges of 1 μC, –2 μC, 1 μC and –2 μC are placed at the corners A, B, C and D respectively, of a square of side 30 cm. Find the net force acting on a charge of 4 μC placed at the centre of the square.

OR

18. (b) Three point charges, 1 pC each, are kept at the vertices of an equilateral triangle of side 10 cm. Find the net electric field at the centroid of triangle.

19. 10 cm फोकस दूरी का कोई पतला अभिसारी लेंस 15 cm फोकस दूरी के किसी पतले अपसारी लेंस के सम्पर्क में समाक्ष रखा है । यह संयोजन किस प्रकार व्यवहार करेगा ? अपने उत्तर की पुष्टि कीजिए ।

20. ड्यूटेरियम नीचे दिए अनुसार संलयन अभिक्रिया करता है :

$$_{1}^{2}\mathrm{H} + {}_{1}^{2}\mathrm{H} \longrightarrow {}_{2}^{3}\mathrm{He} + {}_{0}^{1}\mathrm{n} + 3.27\ \mathrm{MeV}$$

2 g ड्यूटेरियम द्वारा मुक्त ऊर्जा का उपयोग करके 200 W के विद्युत बल्ब को कितने समय तक जलाया जा सकता है ?

21. हाइड्रोजन परमाणु में इलेक्ट्रॉन 0.53 Å की त्रिज्या की कक्षा में 2.2×10^6 m/s की चाल से परिक्रमा कर रहा है । चिरप्रतिष्ठित भौतिकी का उपयोग करके इस इलेक्ट्रॉन द्वारा उत्सर्जित प्रकाश की आरम्भिक आवृत्ति परिकलित कीजिए ।

खण्ड – ग

22. (a) (i) लेंज़ नियम लिखिए । ऊर्जा संरक्षण नियम के अनुसार किसी बन्द परिपथ में प्रेरित धारा चुम्बकीय फ्लक्स में परिवर्तन के कारण का विरोध करती है । इसकी पुष्टि कीजिए ।

(ii) 2 m लम्बाई की किसी धातु की छड़ को, 60 rev/s की आवृत्ति से इसके केन्द्र से गुजरने वाले, उस अक्ष, जो इसकी लम्बाई के लम्बवत् है, के परितः घूर्णित कराया गया है । इस क्षेत्र में छड़ के घूर्णन तल के लम्बवत् 2T के किसी एकसमान चुम्बकीय क्षेत्र को चालू किया गया है । इस छड़ के केन्द्र और एक सिरे के बीच प्रेरित e.m.f. परिकलित कीजिए ।

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22. (b) (i) एम्पियर का परिपथीय नियम लिखकर उसकी व्याख्या कीजिए ।

(ii) 20 cm से पृथकित दो लम्बे सीधे तारों से समान दिशा में 5 A और 10 A की धारा प्रवाहित हो रही है । इन तारों के मध्य में स्थित किसी बिन्दु पर नेट चुम्बकीय क्षेत्र का परिमाण और दिशा ज्ञात कीजिए ।

23. किसी धातु के लिए देहली आवृत्ति 3.0×10^{14} Hz है । 9.0×10^{14} Hz आवृत्ति का कोई पुन्ज इस धातु पर आपतन करता है । ज्ञात कीजिए (i) इस धातु का eV में कार्यफलन तथा (ii) फोटोइलेक्ट्रॉनों की अधिकतम चाल ।

24. (a) विद्युत-चुम्बकीय स्पेक्ट्रम के उन भागों का नाम लिखिए जिन्हें (i) ऊष्मीय तरंगें भी कहा जाता है, (ii) वायुमंडल में ओज़ोन-स्तर अवशोषित कर लेता है ।

(b) इन विकिरणों में प्रत्येक के उत्पन्न करने और संसूचन की एक-एक विधि संक्षेप में लिखिए ।

19. A thin converging lens of focal length 10 cm is placed coaxially in contact with a thin diverging lens of focal length 15 cm. How will the combination behave ? Justify your answer.

20. Deuterium undergoes the following fusion reaction :

$$_{1}^{2}H + _{1}^{2}H \longrightarrow _{2}^{3}He + _{0}^{1}n + 3.27 \text{ MeV}$$

How long an electric bulb of 200 W will glow by using the energy released in 2 g of deuterium ?

21. The electron in hydrogen atom is revolving with the speed of 2.2×10^6 m/s in an orbit of radius 0.53 Å. Calculate the initial frequency of light emitted by the electron using classical physics.

SECTION – C

22. (a) (i) State Lenz's Law. In a closed circuit, the induced current opposes the change in magnetic flux that produced it as per the law of conservation of energy. Justify.

(ii) A metal rod of length 2 m is rotated with a frequency 60 rev/s about an axis passing through its centre and perpendicular to its length. A uniform magnetic field of 2T perpendicular to its plane of rotation is switched-on in the region. Calculate the e.m.f. induced between the centre and the end of the rod.

OR

22. (b) (i) State and explain Ampere's circuital law.

(ii) Two long straight parallel wires separated by 20 cm, carry 5 A and 10 A current respectively, in the same direction. Find the magnitude and direction of the net magnetic field at a point midway between them.

23. The threshold frequency for a metal is 3.0×10^{14} Hz. A beam of frequency 9.0×10^{14} Hz is incident on the metal. Calculate (i) the work function (in eV) of the metal and (ii) the maximum speed of photoelectrons.

24. (a) Name the parts of the electromagnetic spectrum which are (i) also known as 'heat waves' and (ii) absorbed by ozone layer in the atmosphere.

(b) Write briefly one method each, of the production and detection of these radiations.

25. (a) किसी p-n संधि डायोड के उस अभिलाक्षणिक की व्याख्या कीजिए जो उसे दिष्टकारी के रूप में उपयोग के लिए उपयुक्त बनाता है ।

(b) परिपथ आरेख की सहायता से किसी पूर्ण तरंग दिष्टकारी की कार्यविधि की व्याख्या कीजिए ।

26. कारण देते हुए निम्नलिखित की व्याख्या कीजिए :

(a) कोई मादित अर्धचालक विद्युत-उदासीन होता है ।

(b) संतुलन की स्थिति में किसी p-n संधि में कोई नेट धारा नहीं होती है ।

(c) किसी डायोड में पश्च धारा व्यावहारिक रूप से अनुप्रयुक्त वोल्टता पर निर्भर नहीं करती है ।

27. कोई इलेक्ट्रॉन वेग $\vec{v} = \left(3 \times 10^6 \frac{\text{m}}{\text{s}}\right)\hat{\text{i}}$ के वेग से गतिमान है । यह किसी चुम्बकीय क्षेत्र $\vec{\text{B}} = (91\ \text{mT})\hat{\text{k}}$ के प्रदेश में प्रवेश करता है ।

(a) इलेक्ट्रॉन पर कार्यरत चुम्बकीय बल $\vec{\text{F}}_\text{B}$ तथा उसके पथ की त्रिज्या परिकलित कीजिए ।

(b) इलेक्ट्रॉन द्वारा चले गए पथ को आरेखित कीजिए ।

28. लम्बाई 5.0 m और अनुप्रस्थकाट क्षेत्रफल 1.0 mm^2 के किसी चालक के सिरों पर 1.0 V का विभवान्तर अनुप्रयुक्त किया गया है । जब इस चालक से 4.25 A धारा प्रवाहित की जाती है तब इलेक्ट्रॉनों का (i) अपवाह वेग तथा (ii) विश्रान्ति काल परिकलित कीजिए ।

(दिया है – चालक में इलेक्ट्रॉनों का संख्या घनत्व, $\text{n} = 8.5 \times 10^{28}\ \text{m}^{-3}$).

खण्ड – घ

29. कोई प्रिज़्म तीन समतल अपवर्तक पृष्ठों से घिरा कोई प्रकाशिक माध्यम होता है । प्रिज़्म से गुजरने वाली कोई प्रकाश-किरण दो पृष्ठों से क्रमागत अपवर्तित होकर अपने मूल पथ से किसी कोण पर विचलित हो जाती है । प्रिज़्म के पदार्थ का अपवर्तनांक नीचे दिए गए संबंध द्वारा व्यक्त किया जाता है

$$\mu = \sin\left(\frac{\text{A} + \delta\text{m}}{2}\right) / \sin\frac{\text{A}}{2}$$

यदि प्रिज़्म के दूसरे पृष्ठ पर आपतन कोण, किसी कोण जिसे क्रांतिक कोण कहते हैं, से अधिक होता है, तो वह किरण दूसरे पृष्ठ से अपवर्तित नहीं होती है और पूर्ण आंतरिक परावर्तित हो जाती है ।

(i) काँच और जल के लिए क्रांतिक कोण क्रमश: θ_1 और θ_2 हैं । काँच-जल अन्तरापृष्ठ के लिए क्रांतिक कोण होगा ($_\text{a}\mu_\text{g} = 1.5$, $_\text{a}\mu_\text{w} = 1.33$)

(A) θ_2 से कम (B) θ_1 और θ_2 के बीच

(C) θ_2 से अधिक (D) θ_1 से कम

25. (a) Explain the characteristics of a p-n junction diode that makes it suitable for its use as a rectifier.

(b) With the help of a circuit diagram, explain the working of a full wave rectifier.

26. Explain the following, giving reasons :

(a) A doped semiconductor is electrically neutral.

(b) In a p-n junction under equilibrium, there is no net current.

(c) In a diode, the reverse current is practically not dependent on the applied voltage.

27. An electron is moving with a velocity $\vec{v} = \left(3 \times 10^6 \frac{\text{m}}{\text{s}}\right)\hat{i}$. It enters a region of magnetic field $\vec{B} = (91\ \text{mT})\hat{k}$.

(a) Calculate the magnetic force $\vec{F}_B$ acting on electron and the radius of its path.

(b) Trace the path described by it.

28. A potential difference of 1.0 V is applied across a conductor of length 5.0 m and area of cross-section 1.0 mm^2. When current of 4.25 A is passed through the conductor, calculate

(i) the drift speed and (ii) relaxation time, of electrons. (Given number density of electrons in the conductor, $n = 8.5 \times 10^{28}\ \text{m}^{-3}$).

SECTION – D

29. A prism is an optical medium bounded by three refracting plane surfaces. A ray of light suffers successive refractions on passing through its two surfaces and deviates by a certain angle from its original path. The refractive index of the material of the prism is given by $\mu = \sin\left(\frac{A + \delta m}{2}\right) / \sin\frac{A}{2}$. If the angle of incidence on the second surface is greater than an angle called critical angle, the ray will not be refracted from the second surface and is totally internally reflected.

(i) The critical angle for glass is θ_1 and that for water is θ_2. The critical angle for glass-water surface would be (given ${}_a\mu_g = 1.5$, ${}_a\mu_w = 1.33$)

(A) less than θ_2 (B) between θ_1 and θ_2

(C) greater than θ_2 (D) less than θ_1

(ii) जब तरंगदैर्ध्य λ और आवृत्ति υ की कोई प्रकाश किरण किसी सघन माध्यम में अपवर्तित होती है तो

(A) λ और υ दोनों में वृद्धि होती हैं ।

(B) λ में वृद्धि होती है परन्तु υ अपरिवर्तित रहती है ।

(C) λ में कमी होती है परन्तु υ अपरिवर्तित रहती है ।

(D) λ और υ दोनों में कमी होती हैं ।

(iii) (a) काँच से पानी में गुजरने वाली किसी प्रकाश की किरण के लिए क्रांतिक कोण निम्नतम होता है :

(A) लाल वर्ण के लिए (B) नीले वर्ण के लिए

(C) पीले वर्ण के लिए (D) बैंगनी वर्ण के लिए

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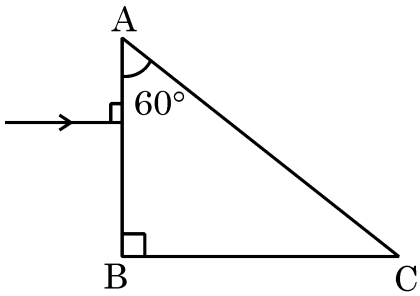
(iii) (b) किसी प्रिज़्म से समान अवस्थाओं में बारी-बारी से लाल, पीले और बैंगनी तीन प्रकाश पुंज गुजारे गए हैं । जब प्रिज्म न्यूनतम विचलन की स्थिति में है तब दूसरे पृष्ठ से अपवर्तन कोण क्रमशः r_R, r_Y और r_V हैं, तब

(A) $r_V < r_Y < r_R$ (B) $r_Y < r_R < r_V$

(C) $r_R < r_Y < r_V$ (D) $r_R = r_Y = r_V$

(iv) आरेख में दर्शाए अनुसार कोई प्रकाश किरण अपवर्तनांक $\sqrt{2}$ के किसी प्रिज़्म ABC पर अभिलम्बवत् आपतन कर रही है । प्रिज़्म के फलक AC से टकराने के पश्चात् यह किरण



(A) बिना विचलित हुए सीधी गमन करेगी ।

(B) फलक AC के अनुदिश ठीक स्पर्श करेगी ।

(C) अपवर्तित होगी और प्रिज़्म से बाहर गमन करेगी ।

(D) पूर्ण आंतरिक परावर्तित होगी ।

(ii) When a ray of light of wavelength λ and frequency v is refracted into a denser medium

(A) λ and v both increase.

(B) λ increases but v is unchanged.

(C) λ decreases but v is unchanged.

(D) λ and v both decrease.

(iii) (a) The critical angle for a ray of light passing from glass to water is minimum for

(A) red colour (B) blue colour

(C) yellow colour (D) violet colour

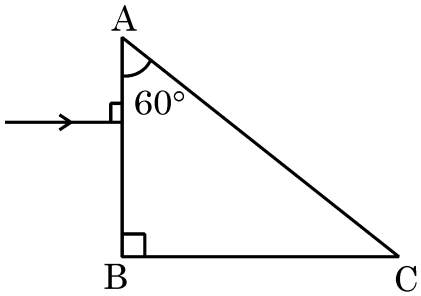
OR

(iii) (b) Three beams of red, yellow and violet colours are passed through a prism, one by one under the same condition. When the prism is in the position of minimum deviation, the angles of refraction from the second surface are r_R, r_Y and r_V respectively. Then

(A) $r_V < r_Y < r_R$ (B) $r_Y < r_R < r_V$

(C) $r_R < r_Y < r_V$ (D) $r_R = r_Y = r_V$

(iv) A ray of light is incident normally on a prism ABC of refractive index $\sqrt{2}$, as shown in figure. After it strikes face AC, it will



(A) go straight undeviated

(B) just graze along the face AC

(C) refract and go out of the prism

(D) undergo total internal reflection

30. संधारित्रों की अभिकल्पना में परावैद्युतों की महत्वपूर्ण भूमिका होती है । किसी परावैद्युत के अणु ध्रुवीय अथवा अध्रुवी हो सकते हैं । जब किसी परावैद्युत गुटके को किसी बाह्य विद्युत क्षेत्र में रखा जाता है, तो विद्युत क्षेत्र के लम्बवत् गुटके के दो पृष्ठों पर विजातीय आवेश प्रकट होते हैं । इन आवेशों के कारण परावैद्युत गुटके के भीतर कोई विद्युत क्षेत्र स्थापित हो जाता है ।

किसी संधारित्र की धारिता उस संधारित्र को दो पट्टिकाओं के बीच के स्थान को भरने वाले पदार्थ के परावैद्युतांक पर निर्भर करता है । परिणामस्वरूप, किसी संधारित्र की ऊर्जा संचित करने की क्षमता भी प्रभावित होती है । प्रतिरोधकों की भाँति संधारित्रों को भी श्रेणी और/या पार्श्व में संयोजित किया जा सकता है ।

(i) निम्नलिखित में से कौन सा ध्रुवीय अणु है ?

(A) O_2 (B) H_2

(C) N_2 (D) HCl

(ii) परावैद्युतों के लिए निम्नलिखित में से कौन सा एक कथन सही है ?

(A) बाह्य विद्युत क्षेत्र की अनुपस्थिति में किसी ध्रुवीय परावैद्युत में नेट द्विध्रुव आघूर्ण होता है जो प्रेरित द्विध्रुवों के कारण परिवर्तित हो जाता है ।

(B) प्रेरित द्विध्रुवों का नेट द्विध्रुव आघूर्ण अनुप्रयुक्त विद्युत क्षेत्र की दिशा के अनुदिश होता है ।

(C) परावैद्युत में मुक्त आवेश होते हैं ।

(D) किसी परावैद्युत के भीतर प्रेरित पृष्ठीय आवेशों के कारण उत्पन्न विद्युत क्षेत्र बाह्य विद्युत क्षेत्र के अनुदिश होता है ।

(iii) जब किसी वियुक्त आवेशित संधारित्र की पट्टिकाओं के बीच किसी परावैद्युत गुटकों को रखा जाता है तो उस संधारित्र में संचित ऊर्जा :

(A) बढ़ जाती है तथा उसके भीतर विद्युत क्षेत्र भी बढ़ जाता है ।

(B) घट जाती है तथा विद्युत क्षेत्र भी घट जाता है ।

(C) घट जाती है तथा विद्युत क्षेत्र बढ़ जाता है ।

(D) बढ़ जाती है तथा विद्युत क्षेत्र घट जाता है ।

(iv) (a) किसी वायु से भरे संधारित्र, जिसकी पट्टिकाओं का क्षेत्रफल A तथा पट्टिकाओं के बीच पृथकन d है, की धारिता C_0 है । इस संधारित्र की पट्टिकाओं के बीच क्षेत्रफल A, मोटाई $\left(\frac{d}{5}\right)$ और परावैद्युतांक K का कोई गुटका रख दिया जाता है । इस संधारित्र की धारिता हो जाएगी –

(A) $\left[\frac{4K}{5K+1}\right]C_0$ (B) $\left[\frac{K+5}{4}\right]C_0$

(C) $\left[\frac{5K}{4K+1}\right]C_0$ (D) $\left[\frac{K+4}{5K}\right]C_0$

अथवा

30. Dielectrics play an important role in design of capacitors. The molecules of a dielectric may be polar or non-polar. When a dielectric slab is placed in an external electric field, opposite charges appear on the two surfaces of the slab perpendicular to electric field. Due to this an electric field is established inside the dielectric.

The capacitance of a capacitor is determined by the dielectric constant of the material that fills the space between the plates. Consequently, the energy storage capacity of a capacitor is also affected. Like resistors, capacitors can also be arranged in series and/or parallel.

(i) Which of the following is a polar molecule ?

(A) O_2 (B) H_2

(C) N_2 (D) HCl

(ii) Which of the following statements about dielectrics is correct ?

(A) A polar dielectric has a net dipole moment in absence of an external electric field which gets modified due to the induced dipoles.

(B) The net dipole moments of induced dipoles is along the direction of the applied electric field.

(C) Dielectrics contain free charges.

(D) The electric field produced due to induced surface charges inside a dielectric is along the external electric field.

(iii) When a dielectric slab is inserted between the plates of an isolated charged capacitor, the energy stored in it :

(A) increases and the electric field inside it also increases.

(B) decreases and the electric field also decreases.

(C) decreases and the electric field increases.

(D) increases and the electric field decreases.

(iv) (a) An air-filled capacitor with plate area A and plate separation d has capacitance C_0. A slab of dielectric constant K, area A and thickness $\left(\frac{d}{5}\right)$ is inserted between the plates. The capacitance of the capacitor will become

(A) $\left[\frac{4K}{5K+1}\right]C_0$ (B) $\left[\frac{K+5}{4}\right]C_0$

(C) $\left[\frac{5K}{4K+1}\right]C_0$ (D) $\left[\frac{K+4}{5K}\right]C_0$

OR

(iv) (b) दो संधारित्रों जिनकी धारिता $2\ C_0$ और $6\ C_0$ हैं को पहले श्रेणी और फिर पार्श्व में संयोजित करके बारी-बारी से समान बैटरी के सिरों से जोड़ा गया है । श्रेणी संयोजन और पार्श्व संयोजन में संचित ऊर्जाओं का अनुपात होगा –

(A) $\frac{1}{4}$ (B) $\frac{1}{6}$

(C) $\frac{2}{15}$ (D) $\frac{3}{16}$

खण्ड – ङ

31. (a) (i) आपको तीन परिपथ अवयव X, Y और Z दिए गए हैं । इन अवयवों को बारी-बारी से किसी दिए गए ac स्रोत से संयोजित किया गया है । यह पाया जाता है कि अवयव X के लिए V और I समान कला में है, अवयव Y के लिए I से V $\left(\frac{\pi}{4}\right)$ अग्र है तथा अवयव Z के लिए V से I $\left(\frac{\pi}{4}\right)$ अग्र है । अवयवों X, Y और Z की पहचान कीजिए ।

(ii) परिपथ की प्रतिबाधा के लिए उस स्थिति में व्यंजक स्थापित कीजिए जब तीनों अवयव X, Y और Z ac स्रोत से श्रेणी में संयोजित हैं । अनुप्रयुक्त ac स्रोत की आवृत्ति के साथ परिपथ की धारा में विचरण को दर्शाने के लिए ग्राफ खींचिए ।

(iii) किसी LCR श्रेणी परिपथ के लिए वह शर्त प्राप्त कीजिए जिसमें (i) परिपथ की प्रतिबाधा निम्नतम होती है तथा (ii) परिपथ में वाटहीन धारा प्रवाहित होती है ।

अथवा

31. (b) (i) किसी ट्रांसफॉर्मर की संरचना तथा कार्यविधि का वर्णन कीजिए और इस प्रकार प्राथमिक और द्वितीयक कुण्डलियों में फेरों की संख्या के पदों में $\left(\frac{v_s}{v_p}\right)$ के लिए संबंध प्राप्त कीजिए ।

(ii) किसी वास्तविक ट्रान्सफॉर्मर में ऊर्जा-क्षय के चार मुख्य कारणों की विवेचना कीजिए ।

32. (a) (i) विरल माध्यम से सघन माध्यम में संचरण करती कोई समतल प्रकाश तरंग दोनों माध्यमों को पृथक करने वाले पृष्ठ पर किसी कोण i पर आपतन कर रही है । हाइगेन्स नियम का उपयोग करके अपवर्तित किरण खींचिए और इस प्रकार स्नैल के अपवर्तन के नियम का सत्यापन कीजिए ।

(ii) यंग के द्वि-झिरी प्रयोग में झिरियों के बीच पृथकन 0.30 mm और पर्दे की झिरियों से दूरी 1.5 m है । उपयोग किए गए प्रकाश की तरंगदैर्ध्य 600 nm है । केन्द्रीय चमकीली फ्रिंज और चौथी काली फ्रिंज के बीच की दूरी परिकलित कीजिए ।

अथवा

(iv) (b) Two capacitors of capacitances 2 C_0 and 6 C_0 are first connected in series and then in parallel across the same battery. The ratio of energies stored in series combination to that in parallel is

(A) $\frac{1}{4}$ (B) $\frac{1}{6}$

(C) $\frac{2}{15}$ (D) $\frac{3}{16}$

SECTION – E

31. (a) (i) You are given three circuit elements X, Y and Z. They are connected one by one across a given ac source. It is found that V and I are in phase for element X. V leads I by $\left(\frac{\pi}{4}\right)$ for element Y while I leads V by $\left(\frac{\pi}{4}\right)$ for element Z. Identify elements X, Y and Z.

(ii) Establish the expression for impedance of circuit when elements X, Y and Z are connected in series to an ac source. Show the variation of current in the circuit with the frequency of the applied ac source.

(iii) In a series LCR circuit, obtain the conditions under which (i) impedance is minimum and (ii) wattless current flows in the circuit.

OR

31. (b) (i) Describe the construction and working of a transformer and hence obtain the relation for $\left(\frac{v_s}{v_p}\right)$ in terms of number of turns of primary and secondary.

(ii) Discuss four main causes of energy loss in a real transformer.

32. (a) (i) A plane light wave propagating from a rarer into a denser medium, is incident at an angle i on the surface separating two media. Using Huygen's principle, draw the refracted wave and hence verify Snell's law of refraction.

(ii) In a Young's double slit experiment, the slits are separated by 0.30 mm and the screen is kept 1.5 m away. The wavelength of light used is 600 nm. Calculate the distance between the central bright fringe and the 4^{th} dark fringe.

OR

32. (b) (i) किसी एकल झिरी से प्रकाश के विवर्तन की संक्षिप्त विवेचना कीजिए और विवर्तन पैटर्न की आकृति खींचिए ।

(ii) कोई बिम्ब किसी अवतल दर्पण के ध्रुव और फोकस के बीच स्थित है । दर्पण सूत्र का उपयोग करके गणितीय रूप में सिद्ध कीजिए कि दर्पण द्वारा बना प्रतिबिम्ब आभासी और विवर्धित होगा ।

33. (a) (i) किसी विद्युत द्विध्रुव के लिए समविभव पृष्ठ आरेखित कीजिए ।

(ii) दो बिन्दु आवेश q_1 और q_2 किसी बाह्य विद्युत क्षेत्र $\vec{E}$ में क्रमशः $\vec{r}_1$ और $\vec{r}_2$ पर स्थित हैं । इस निकाय की स्थितिज ऊर्जा के लिए व्यंजक प्राप्त कीजिए ।

(iii) किसी अणु का द्विध्रुव आघूर्ण 10^{-30} Cm है । यह द्विध्रुव 10^5 V/m के विद्युतक्षेत्र $\vec{E}$ में इस प्रकार स्थित है कि इसका अक्ष विद्युत क्षेत्र के अनुदिश है । विद्युत क्षेत्र की दिशा को किसी क्षण अचानक $60°$ के कोण पर परिवर्तित किया जाता है । उसी क्षण पर द्विध्रुव की स्थितिज ऊर्जा में परिवर्तन ज्ञात कीजिए ।

अथवा

33. (b) (i) त्रिज्या R के किसी पतले गोलीय खोल का एकसमान पृष्ठीय आवेश घनत्व σ है । गाउस नियम का उपयोग करके इस खोल के (i) बाहर और (ii) भीतर विद्युत क्षेत्र के लिए व्यंजक व्युत्पन्न कीजिए ।

(ii) दो लम्बे सीधे पतले तारों AB और CD के रैखिक आवेश घनत्व क्रमश: 10 μC/m और -20 μC/m हैं । ये तार एक दूसरे के समान्तर 1 m दूरी पर स्थित हैं । इन तारों के मध्य बिन्दु पर नेट विद्युत क्षेत्र का परिमाण और दिशा ज्ञात कीजिए ।

32. (b) (i) Discuss briefly diffraction of light from a single slit and draw the shape of the diffraction pattern.

(ii) An object is placed between the pole and the focus of a concave mirror. Using mirror formula, prove mathematically that it produces a virtual and an enlarged image.

33. (a) (i) Draw equipotential surfaces for an electric dipole.

(ii) Two point charges q_1 and q_2 are located at $\vec{r}_1$ and $\vec{r}_2$ respectively in an external electric field $\vec{E}$. Obtain an expression for the potential energy of the system.

(iii) The dipole moment of a molecule is 10^{-30} Cm. It is placed in an electric field $\vec{E}$ of 10^5 V/m such that its axis is along the electric field. The direction of $\vec{E}$ is suddenly changed by 60° at an instant. Find the change in the potential energy of the dipole, at that instant.

OR

33. (b) (i) A thin spherical shell of radius R has a uniform surface charge density σ. Using Gauss' law, deduce an expression for electric field (i) outside and (ii) inside the shell.

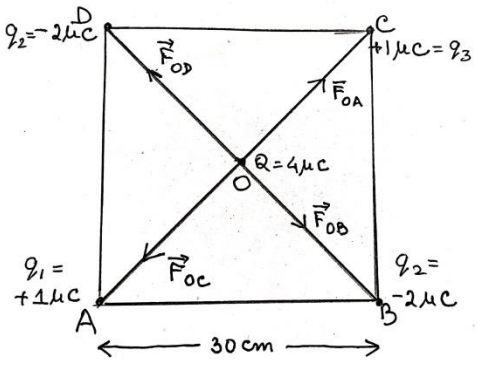
(ii) Two long straight thin wires AB and CD have linear charge densities 10 μC/m and –20 μC/m, respectively. They are kept parallel to each other at a distance 1 m. Find magnitude and direction of the net electric field at a point midway between them.

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT PHYSICS (CODE 55/5/1)

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

	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 _____(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.

MARKING SCHEME : PHYSICS (042)			
CODE : 55/5/1			
Q.NO.	**VALUE POINTS/ EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION - A		
1.	(D) $0.5\,\Omega$	1	1
2.	(D) 4R	1	1
3.	(B) Sodium and Calcium	1	1
4.	(C) $5.2\,k\Omega$	1	1
5.	(A) 0.4 mH	1	1
6.	(B) Ultraviolet rays	1	1
7.	(D) 125	1	1
8.	(A) A	1	1
9.	(C) 3.4 eV, –6.8 eV	1	1
10	(C) 8^{th}	1	1
11	(A) 0.8 fm	1	1
12	(B) 1.5×10^{16}	1	1
13	(C) Assertion (A) is true but Reason (R) is false.	1	1
14	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).	1	1
15	(C) Assertion (A) is true but Reason (R) is false.	1	1
16	(D) Both Assertion (A) and Reason (R) are false.	1	1
	SECTION - B		
17	(a) Diagram showing direction of forces 1 Finding net force 1  OA = OB = OC = OD = r Net force on charge $4\mu C$	1	

$\vec{F} = \vec{F}_{OA} + \vec{F}_{OB} + \vec{F}_{OC} + \vec{F}_{OD}$

$\vec{F}_{OA} = -\vec{F}_{OC} \quad \Rightarrow \vec{F}_{OA} + \vec{F}_{OC} = 0$

$\vec{F}_{OB} = -\vec{F}_{OD} \quad \Rightarrow \vec{F}_{OB} + \vec{F}_{OD} = 0$

$\vec{F} = 0$ ½

Alternatively

$$F_{OA} = F_{OC} = \frac{9\times10^{9}\times4\times10^{-6}\times1\times10^{-6}}{(15\sqrt{2}\times10^{-2})^{2}}$$

$= 0.8\,\text{N}$

$F_{OB} = F_{OD} = 1.6\ \text{N}$ ½

$F_1 = F_{OA} - F_{OC} = 0$

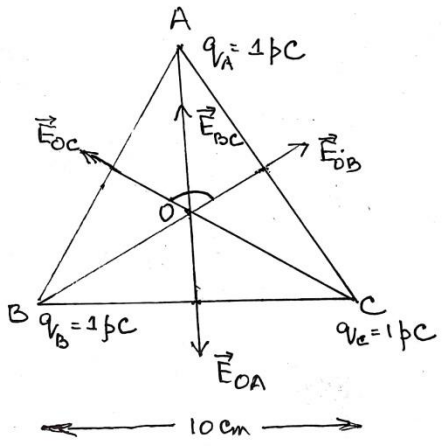
$F_2 = F_{OB} - F_{OD} = 0$

Net Force $F = 0$ ½

OR

(b)

Finding net electric field at centroid	2



1

$q_A = q_B = q_C = 1\text{pC}$

$AO = BO = CO = r$

$|\vec{E}_{OA}| = |\vec{E}_{OB}| = |\vec{E}_{OC}|$

$\vec{E}_{BC} = \vec{E}_{OB} + \vec{E}_{OC}$

$E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos120^0}$ ½

$E_{BC} = E_{OB} \quad , \quad \vec{E}_{OA} = -\vec{E}_{BC}$

Net electric field $\vec{E}_O = \vec{E}_{OA} + \vec{E}_{BC}$

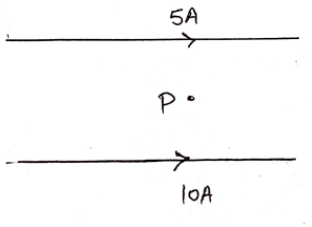
$\vec{E}_O = 0$ ½

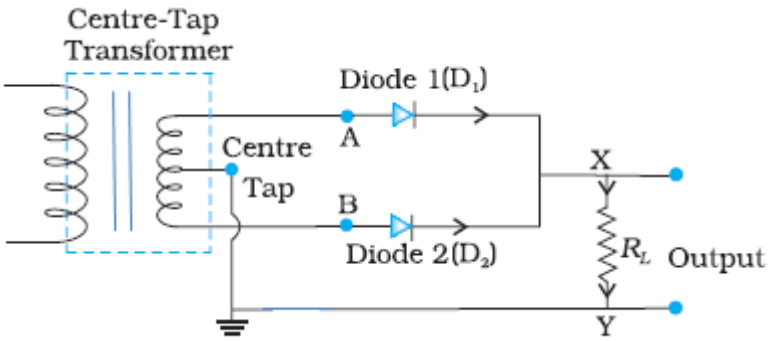
Alternatively

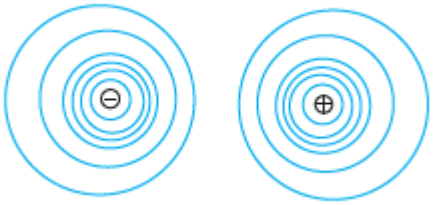
	$E_{OA} = E_{OB} = E_{OC} = 2.7\ \text{NC}^{-1}$ $E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^0}$ $= E_{OB}$ *As* $\vec{E}_{BC} = -\vec{E}_{OA}$ $\vec{E}_{BC} + \vec{E}_{OA} = 0$ Net electric field is zero. **Alternatively** $\lvert\vec{E}_{OA}\rvert = \lvert\vec{E}_{OB}\rvert = \lvert\vec{E}_{OC}\rvert$ Electric field vectors are making an angle of 120^0 with each other. They make a closed polygon. So vector sum of all electric field vectors will be zero. $\vec{E} = 0$	½ ½ 2	2
18	Deriving an expression for magnetic force 1½ Validity and Justification for zig-zag form conductor ½ Total number of mobile charge carriers in a conductor of length L, cross-sectional area A and number density of charge carriers n: $= nLA$ Force acting on the charge carriers in external magnetic field $\vec{B}$ $\vec{F} = (nAL)\,q\vec{v}_d \times \vec{B}$ ------(1) Where $\vec{v}_d$ is the drift velocity of the charge carriers Current flowing $I = v_d qnA$ $I\vec{L} = \vec{v}_d qnAL$ ------(2) On solving equation (1) and (2) $\vec{F} = I(\vec{L} \times \vec{B})$ Yes, because this force can be calculated by considering zig-zag conductor as a collection of linear strips $(d\vec{l})$ and summing them vectorically.	½ ½ ½ ½	2
19	Calculation of magnifying power 1 Calculation of image distance 1 $\lvert m\rvert = \frac{f_0}{f_e}$ $= \frac{150}{5} = 30$ $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$	½ ½ ½	

	$\frac{1}{150}=\frac{1}{v}-\frac{1}{\infty}$ $v=150\,\text{cm}$ (Note: Award full credit of this part, if a student writes correct distance of image without calculation i.e. using object position at infinity.)	½ 2	
20	(a) Finding the wavelength 1½ (b) Identifying series ½ (a) $E_2-E_1=\frac{hc}{\lambda}$ Given $E_2-E_1=2.55\times1.6\times10^{-19}$ J $\Rightarrow \quad \lambda=\frac{6.63\times10^{-34}\times3\times10^{8}}{2.55\times1.6\times10^{-19}}=487.5\,\text{nm}$ (b) Balmer series	½ ½ ½ ½	2
21	Finding the quantum number 2 Using Bohr's model $mvr=\frac{nh}{2\pi}$ $n=\frac{2\pi\times6.0\times10^{24}\times30\times10^{3}\times1.5\times10^{11}}{6.63\times10^{-34}}$ $n=2.558\times10^{74}$	1 ½ ½	2
	SECTION - C		
22	(a) Writing Einstein's photoelectric equation 1½ Milliken's proof for the validity (b) Explanation of existence of threshold frequency 1½ (a) $h\nu=h\nu_0+K_{max}=h\nu_0+eV_0$ By finding the value of Planck's constant using V_0 versus υ straight line plot for sodium. (b) Since K_{max} must be non- negative therefore photo-electric emission is possible only when $h\nu > h\nu_0$, which implies the existence of ν_0.	1½ 1½	3
23	(a) Defining the term electric flux 1 Writing dimensions ½ (b) Finding the electric flux 1½ (a) It is the measure of the total number of electric field lines passing through a surface normally. **Alternatively**	1	

	Surface integral of electric field over a surface. **Alternatively** $\phi_E = \vec{E} \cdot \vec{A}$ $\left[ML^3T^{-3}A^{-1}\right]$ (b) $\phi_E = \vec{E}.\vec{A}$ $=(100\hat{i}).(10^{-4}\hat{n})$ $=(100\hat{i}).(0.8\hat{i}+0.6\hat{k})10^{-4}$ $=8\times10^{-3}$ Nm^2C^{-1}	½ ½ ½ ½	3
24	**(a)** (i) Statement of Lenz's Law 1 Justification ½ (ii) Calculating emf induced 1½ (i) The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. In a closed loop, when the polarity of induced emf is such that, the induced current favours the change in magnetic flux then the magnetic flux and consequently the current will go on increasing without any external source of energy. This violates law of conservation of energy. $\varepsilon = \frac{1}{2}Bl^2\omega$ $=\frac{1}{2}\times2\times(2)^2\times(2\pi\times60)$ $=480\pi$ V $=1.51\times10^3$ V **OR** **(b)** (i) Statement and explanation of Ampere's circuital law 1 (ii) Finding magnitude and direction of magnetic field 2 (i) Line integral of magnetic field over a closed loop in vacuum is equal to μ_0 times the total current passing through the loop. **Alternatively** $\oint \vec{B} \cdot \vec{dl} = \mu_0 I$ The integral in this expression is over a closed loop coinciding with the boundary of the surface.	1 ½ ½ ½ ½ 1	

	(ii)  $B = \frac{\mu_0 I}{2\pi r}$ Net magnetic field $B = B_2 - B_1$ $B = \frac{\mu_0 \times 10^2}{20\pi}[10-5]$ $B = \frac{4\pi \times 10^{-7} \times 10^2 \times 5}{20\pi}$ $B = 10^{-5}\,\text{T}$ Along the direction of magnetic field produced by the conductor carrying current 10A.	½ ½ ½ ½	3
25	Finding the radius of circular path 1 Answer for linear path ½ Calculation of linear distance covered 1½ Radius of circular path $r = \frac{mv_x}{eB}$ $r = \frac{9.1\times10^{-31}\times1\times10^{7}}{1.6\times10^{-19}\times0.5\times10^{-3}}$ $= 11.38\times10^{-2}\,\text{m}$ Yes, it traces a linear path too. Linear distance during period of one revolution $y = \frac{2\pi m}{eB}\times v_y$ $= \frac{2\times\pi\times9.1\times10^{-31}\times0.5\times10^{7}}{1.6\times10^{-19}\times0.5\times10^{-3}}$ $= 0.357\,\text{m}$ $= 0.36\ \text{m}$	½ ½ ½ ½ ½ ½	3
26	(a) Naming the parts of electromagnetic spectrum for (i) and (ii) ½ +½ (b) Writing one method of production and detection of each ½×4 (a) (i) Infrared waves (ii) Ultraviolet Rays	½ ½	

	(b) Method of production Infrared waves: Hot bodies / Vibration of atoms and molecules Ultraviolet Rays: Special UV lamps / Sun / Very hot bodies Method of detection Infrared waves: Thermopiles / IR photographic film / Bolometer Ultraviolet Rays: Photocells / photographic film	½ ½ ½ ½	3
27	(a) Characteristics of p-n junction diode that makes it suitable for rectification 1 (b) Circuit diagram 1 Explanation of working of full wave rectifier 1 (a) p-n junction diode allows current to pass only when it is forward biased (b)  When input voltage to A, with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative, diode D_1 gets forward biased and conducts while D_2 being reverse biased does not conduct. Hence during this half cycle an output current and output voltage across R_L is obtained. During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive. Hence D_1 would not conduct but D_2 would be giving an output current and output voltage. Thus output voltage is obtained during both halves of the cycle.	1 1 1	3
28	Explanation of (a), (b) and(c) 1+1+1 (a) Charge of additional charge carriers is just equal and opposite to that of the ionised cores in the lattice. (b) Under equilibrium, the diffusion current is equal to the drift current. (c) Reverse current is limited due to concentration of minority charge carriers on either side of the junction.	1 1 1	3
	SECTION - D		
29	(i) (D) HCl (ii) (B) The net dipole moment of induced dipoles is along the direction of the applied electric field.	1 1	

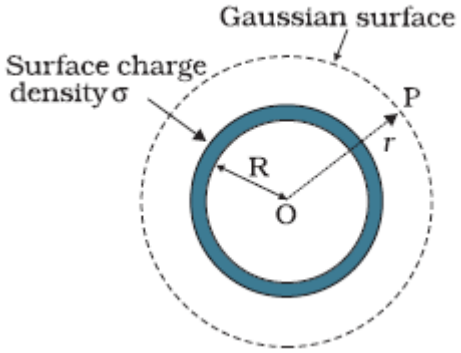
	(iii) (B) decreases and the electric field also decreases. (iv) (a) (C) $\left[\frac{5K}{4K+1}\right]C_0$ **OR** (iv) (b) (D) $\frac{3}{16}$	1 1	4
30	(i) (C) greater than θ_2 (ii) (C) λ decreases but ν is unchanged (iii) (a) (D) violet colour OR (iii) (b) (C) $r_R < r_Y < r_V$ (iv) (D) undergo total internal reflection	1 1 1 1	4
	SECTION - E		
31	(a) (i) Drawing equipotential surfaces 1 (ii) Obtaining an expression for potential energy 2 (iii) Finding the change in potential energy 2 (i)  (ii) Work done in bringing a charge q_1 from infinity to $\vec{r}_1$: $W_1 = q_1V(\vec{r}_1)$ ----------(1) Work done in bringing a charge q_2 from infinity to $\vec{r}_2$ against the external field : $W_2 = q_2V(\vec{r}_2)$ ----------(2) Work done on q_2 against the field due to q_1: $W_{12} = \frac{q_1q_2}{4\pi\varepsilon_0 r_{12}}$ ----------(3) Potential energy of the system = Total work done $= q_1V(\vec{r}_1) + q_2V(\vec{r}_2) + \frac{q_1q_2}{4\pi\varepsilon_0 r_{12}}$ (iii) Change in Potential energy = Work done $W = pE[\cos\theta_0 - \cos\theta_1]$ $W = 10^{-30} \times 10^5 [\cos0^0 - \cos60^0]$ $W = 5.0 \times 10^{-26}$ J **OR**	 1 ½ ½ ½ 1 ½ ½	

(b)

(i) Deduction of an expression for electric field for (i) and (ii)	3
(ii) Finding magnitude and direction of the net electric field	2

(i)

(i) **Electric Field outside the shell**



½

Electric flux through Gaussian surface

$\Phi = E \times 4\pi r^2$

Charge enclosed by the Gaussian surface

$Q = \sigma \times 4\pi R^2$

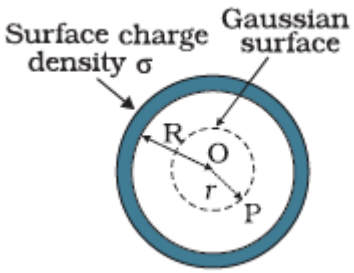
Using Gauss' law: $\int \vec{E}.\vec{ds} = \frac{Q}{\varepsilon_0}$ ½

$E \times 4\pi r^2 = \frac{(\sigma 4\pi R^2)}{\varepsilon_0}$

$\therefore E = \frac{\sigma R^2}{\varepsilon_0 r^2}$ ½

$\vec{E} = \frac{\sigma R^2}{\varepsilon_0 r^2}\hat{r}$

(ii) **Field inside the shell**



½

Electric flux through Gaussian surface

$\Phi = E \times 4\pi r^2 \qquad (\because r < R)$

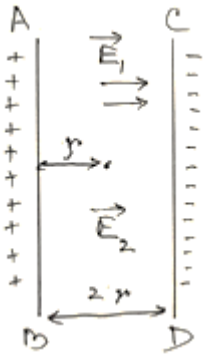
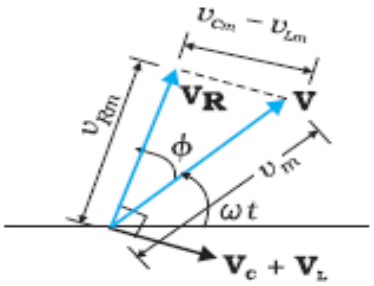
Charge enclosed by the Gaussian surface

$Q = 0$

By Gauss' Law

$E \times 4\pi r^2 = 0$ ½

i.e. $E = 0$ ½

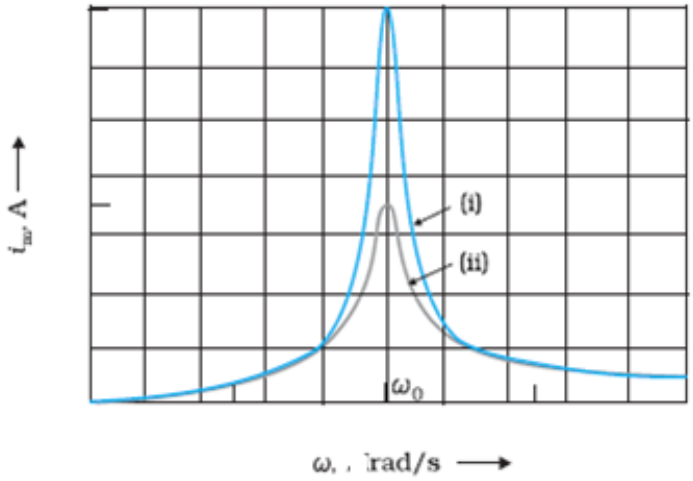
	(Note: Award full credit of this part if a student writes directly E=0, mentioning as there is no charge enclosed by Gaussian surface) **(ii)** Electric field due to a long straight charged wire of linear charged density λ $E = \frac{\lambda}{2\pi\varepsilon_0 r}$  Net electric field at the mid-point $E_{net} = E_1 + E_2$ $= \frac{\lambda_1}{2\pi\varepsilon_0 r} + \frac{\lambda_2}{2\pi\varepsilon_0 r}$ $E_{net} = \frac{1}{2\pi\varepsilon_0 r}[\lambda_1 + \lambda_2]$ $= \frac{2\times 9\times 10^9}{0.5}[10+20]\times 10^{-6}$ $= 1.08 \times 10^6\ NC^{-1}$ $\vec{E}_{net}$ is directed towards CD.	½ ½ ½ ½	5
32	(a) (i) To identify the circuit element X, Y & Z 1½ (ii) To establish relation for impedance 2 Showing variation in current with frequency ½ (iii) To obtain condition for- (i) Minimum impedance ½ (ii) Wattless current ½ (i) X : Resistor Y : real inductor (such that its reactance is equal to its resistance) / Inductor Z : real capacitor (such that its reactance is equal to its resistance)/ Capacitor (ii)  	½ ½ ½ ½	

From the fig.

$V_m^2 = V_{Rm}^2 + (V_{Cm} - V_{Lm})^2$ ½

$V_m^2 = (i_m R)^2 + (i_m X_C - i_m X_L)^2$ ½

Impedance $(Z) = \frac{V_m}{I_m} = \sqrt{R^2 + (X_C - X_L)^2}$ ½



½

(iii) $Z = \sqrt{R^2 + (X_C - X_L)^2}$

For the minimum value of impedance

(i) $X_C = X_L$ ½

(ii) Average power consumed in A.C. circuit over a cycle

$P = VI \cos\varphi$

For wattless current $P = 0$

Since $V \neq 0, I \neq 0$

$\cos\varphi = 0$

i.e. $\varphi = \frac{\pi}{2}$ ½

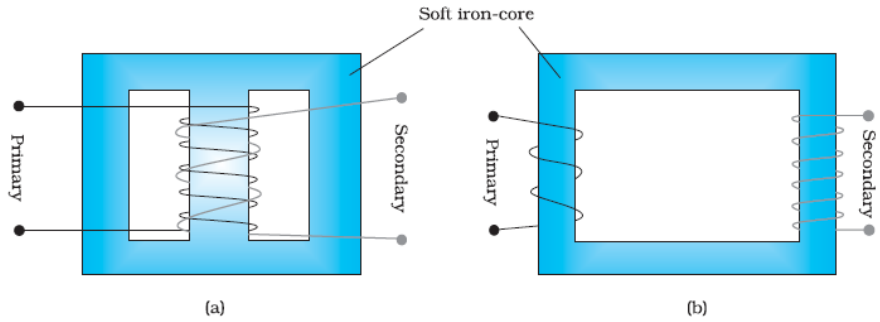
OR

(b)

(i) Description of Construction and working	1+1
Obtaining relation $(\frac{V_S}{V_P})$	1
(ii) Causes of energy losses	2

(i) **Construction:** A transformer consists of two sets of coils, insulated from each other. They are wound on a soft- iron core, either one on top of other or on separate limbs of the core.

Alternatively



1

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

For an ideal transformer the induced emf (ε_p) in primary coil for applied alternating voltage (V_P)

$$\varepsilon_p = V_P = -N_P \frac{d\phi}{dt} \quad \text{----------(1)}$$ ½

e.m.f. induced ε_S in the secondary coil

$$\varepsilon_S = V_S = -N_S \frac{d\phi}{dt} \quad \text{----------(2)}$$

From eq. (1) and (2)

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$ ½

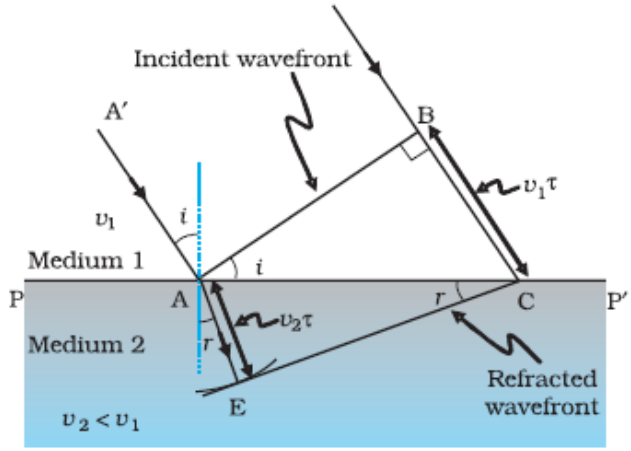
(ii) Any four energy losses
1. Flux leakage.
2. Resistance of windings/ copper loss.
3. Eddy currents/iron loss.
4. Hysteresis.
5. Magnetostriction.

$\frac{1}{2} \times 4$ 5

33 (a)

(i) Drawing refracted wavefront and Verification of Snell's law	3
(ii) Calculation of distance	2

(i)



1

Considering triangles ABC and AEC

$\sin i = \frac{BC}{AC} = \frac{v_1 \tau}{AC}$ and ------(1) ½

$\sin r = \frac{AE}{AC} = \frac{v_2 \tau}{AC}$ ------(2)

From equation (1) and equation (2)

$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$ ------(3) ½

If c represents the speed of light in vacuum, then

$n_1 = \frac{c}{v_1}$ and $n_2 = \frac{c}{v_2}$ ½

In terms of refractive indices

$n_1 \sin i = n_2 \sin r$

which is Snell's law of refraction. ½

(ii)

$X_4 = \frac{(2n-1)\lambda D}{2d}$ ½

$X_4 = \frac{(2\times 4-1)\times 600\times 10^{-9}\times 1.5}{2\times 0.3\times 10^{-3}}$ 1

$= 1.05\times 10^{-2}$ m ½

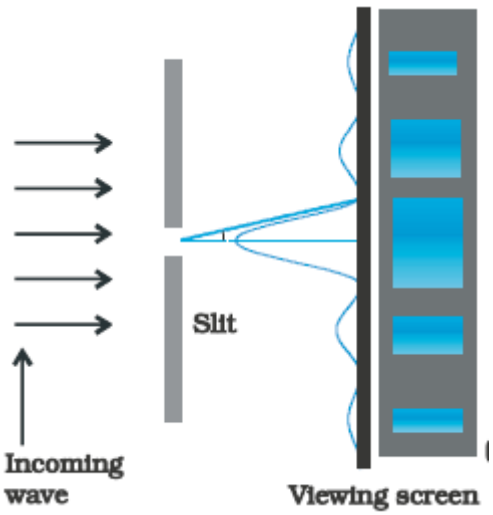
OR

(b)

(i) Brief discussion of Diffraction of light and drawing the shape of diffraction pattern	2+1
(ii) Proof using mirror formula	2

(i) A beam of light falls normally on a single slit and bends around its corners. This phenomenon is called diffraction. 1

When a beam of light falls normally on a narrow single slit, then diffracted light goes on to meet on a screen. It is observed that at the center of the screen intensity is maximum and goes on decreasing as one move away from the center on either side of screen. 1



1

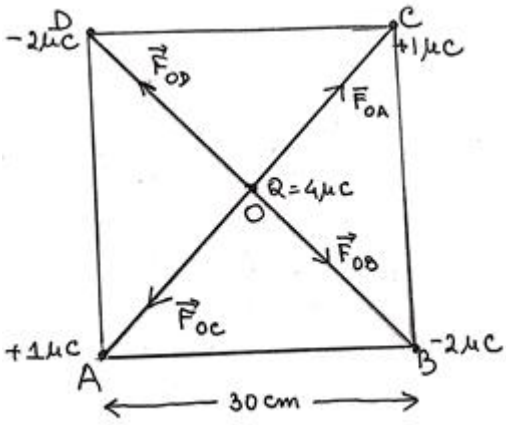
	(ii) $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ $v=\frac{uf}{u-f}$ Following new cartesian sign conversion $v=\frac{(-u)(-f)}{-u-(-f)}$ $v=\frac{uf}{f-u}$ as $f > u$ v is +ve, So image is virtual. $m=-\frac{v}{u}=\frac{f}{f-u}>1$ i.e. Enlarged image	1 1	5

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT PHYSICS (CODE 55/5/2)

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 deliberation 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 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 _____(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.

MARKING SCHEME : PHYSICS (042)			
CODE : 55/5/2			
Q.NO.	**VALUE POINTS/ EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
1.	(A) A will increase, V will decrease	1	1
2.	(B) lags the voltage by $\left(\frac{1}{4}\right)$ cycle	1	1
3.	(B) A force of attraction and a torque	1	1
4.	(C) $\frac{2I - I_g}{I - I_g}$	1	1
5.	(C) 1.5V	1	1
6.	(B) 1.5×10^{16}	1	1
7.	(A) 0.8 fm	1	1
8.	(C) 0.33 mm	1	1
9.	(A) A	1	1
10	(C) 3.4 eV, –6.8 eV	1	1
11	(B) Ultraviolet rays	1	1
12	(D) 125	1	1
13	(D) Both Assertion (A) and Reason (R) are false.	1	1
14	(C) Assertion (A) is true but Reason (R) is false.	1	1
15	(C) Assertion (A) is true but Reason (R) is false.	1	1
16	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).	1	1
	SECTION - B		
17	(a) Finding net electric field 2  OA = OB = OC = OD = r Net force on charge 4μC	1	

$\vec{F} = \vec{F}_{OA} + \vec{F}_{OB} + \vec{F}_{OC} + \vec{F}_{OD}$

$\vec{F}_{OA} = -\vec{F}_{OC} \quad \Rightarrow \vec{F}_{OA} + \vec{F}_{OC} = 0$

$\vec{F}_{OB} = -\vec{F}_{OD} \quad \Rightarrow \vec{F}_{OB} + \vec{F}_{OD} = 0$

$\vec{F} = 0$ ½

Alternatively

$$F_{OA} = F_{OC} = \frac{9\times10^{9}\times4\times10^{-6}\times1\times10^{-6}}{(15\sqrt{2}\times10^{-2})^{2}}$$

$= 0.8\,\text{N}$

$F_{OB} = F_{OD} = 1.6\ \text{N}$ ½

$F_1 = F_{OA} - F_{OC} = 0$

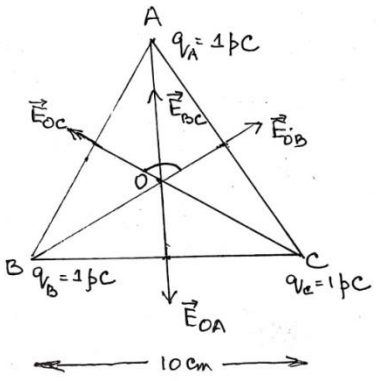
$F_2 = F_{OB} - F_{OD} = 0$ ½

Net Force $F = 0$

OR

(b)

Finding net electric field at centroid	2



1

$q_A = q_B = q_C = 1\text{pC}$

$AO = BO = CO = r$

$|\vec{E}_{OA}| = |\vec{E}_{OB}| = |\vec{E}_{OC}|$

$\vec{E}_{BC} = \vec{E}_{OB} + \vec{E}_{OC}$

$E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^0}$ ½

$E_{BC} = E_{OB} \quad , \quad \vec{E}_{OA} = -\vec{E}_{BC}$

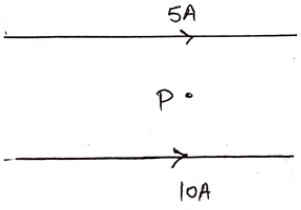
Net electric field $\vec{E}_O = \vec{E}_{OA} + \vec{E}_{BC}$

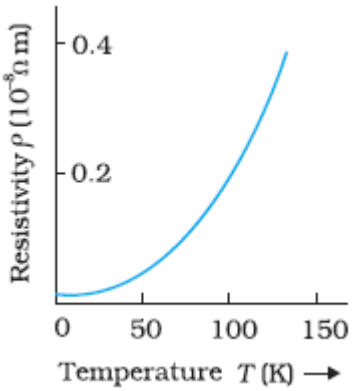
$\vec{E}_O = 0$ ½

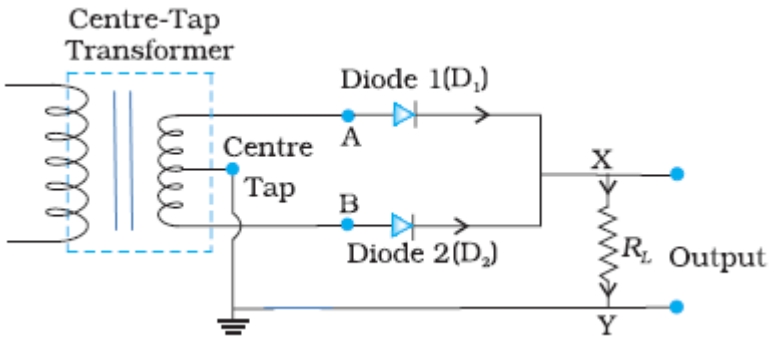
Alternatively

	$E_{OA} = E_{OB} = E_{OC} = 2.7\ \text{NC}^{-1}$ $E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^0}$ $= E_{OB}$ *As* $\vec{E}_{BC} = -\vec{E}_{OA}$ $\vec{E}_{BC} + \vec{E}_{OA} = 0$ Net electric field is zero. **Alternatively** $\lvert\vec{E}_{OA}\rvert = \lvert\vec{E}_{OB}\rvert = \lvert\vec{E}_{OC}\rvert$ Electric field vectors are making an angle of 120^0 with each other. They make a closed polygon. So vector sum of all electric field vectors will be zero. $\vec{E} = 0$	½ ½ 2	2
18	Deriving an expression for magnetic force 1½ Validity and Justification for zig-zag form conductor ½ Total number of mobile charge carriers in a conductor of length L, cross-sectional area A and number density of charge carriers n: $= nLA$ Force acting on the charge carriers in external magnetic field $\vec{B}$ $\vec{F} = (nAL)\,q\vec{v}_d \times \vec{B}$ ------(1) Where $\vec{v}_d$ is the drift velocity of the charge carriers Current flowing $I = v_d qnA$ $I\vec{L} = \vec{v}_d qnAL$ ------(2) On solving equation (1) and (2) $\vec{F} = I(\vec{L} \times \vec{B})$ Yes, because this force can be calculated by considering zig-zag conductor as a collection of linear strips $(d\vec{l})$ and summing them vectorically.	½ ½ ½ ½	2
19	Finding separation 2 $m = -\frac{v}{u} = \frac{h_I}{h_O} = \frac{1}{2}$ $u = -2v$ $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$	½ ½	

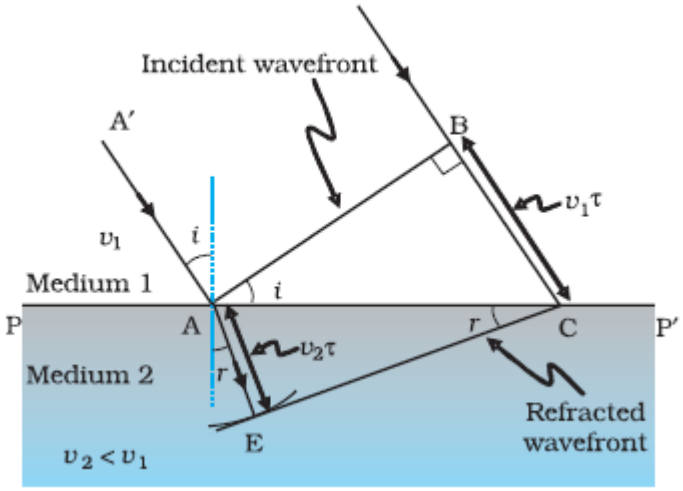
	$\frac{1}{15}=\frac{1}{v}-\frac{1}{2v}$ On solving $\lvert v\rvert = 7.5\,\text{cm}$ $\lvert u\rvert = +15.0\,\text{cm}$ Separation = 15.0 + 7.5 = 22.5 cm	 ½ ½	 2
20	Calculating energy 2 Mass of reactants = (1.007825 + 3.016049) u = 4.023874 u Mass of product = 2 × 2.014102 u = 4.028204 u Mass defect , Δm = 4.023874 u – 4.028204 u = - 0.00433 u As the mass defect is negative, energy is absorbed. Energy absorbed, E = 0.00433 × 931.5 MeV = 4.03 MeV	 1 ½ ½	 2
21	Finding distance of closest approach 2 $d_0=\frac{kZe^2}{K_p}$ $=\frac{9\times10^9\times79\times(1.6\times10^{-19})^2}{1.6\times1.6\times10^{-19}\times10^6}$ $=711\times10^{-16}\,\text{m}$ $=7.11\times10^{-14}\,\text{m}$	 ½ ½ + ½ ½	 2
	SECTION - C		
22	(i) Calculating threshold wavelength 1 (ii) Energy of incident photon 1 (iii) Maximum kinetic energy 1 (a) $\phi_0=\frac{hc}{\lambda_0}$ (i) $\lambda_0=\frac{6.63\times10^{-34}\times3\times10^8}{2.1\times1.6\times10^{-19}}$ $=5.92\times10^{-7}\,\text{m}$	 ½ ½	

	(ii) Energy of incident photon = $\frac{hc}{\lambda}$ $= \frac{6.63\times10^{-34}\times3\times10^{8}}{150\times10^{-19}\times1.6\times10^{-19}}$ $= 8.29\,\text{eV}$ (iii) Using Einstein equation $\frac{hc}{\lambda} = \phi_0 + K_{max}$ $K_{max} = (8.29 - 2.1)\text{eV}$ $= 6.2\,\text{eV}$	½ ½ ½ ½	3
23	(a) (i) Statement of Lenz's Law 1 Justification ½ (ii) Calculating emf induced 1½ (a) (i) The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. In a closed loop, when the polarity of induced emf is such that, the induced current favours the change in magnetic flux then the magnetic flux and consequently the current will go on increasing without any external source of energy. This violates law of conservation of energy. $\varepsilon = \frac{1}{2}Bl^2\omega$ $= \frac{1}{2}\times2\times(2)^2\times(2\pi\times60)$ $= 480\pi$ V $= 1.51\times10^3$ V **OR** (b) (i) Statement and explanation of Ampere's circuital law 1 (ii) Finding magnitude and direction of magnetic field 2 Line integral of magnetic field over a closed loop in vacuum is equal to μ_0 times the total current passing through the loop. **Alternatively** $\oint \vec{B}\cdot\vec{dl} = \mu_0 I$ The integral in this expression is over a closed loop coinciding with the boundary of the surface. (ii)  	1 ½ ½ ½ ½ 1	

	$B = \frac{\mu_0 I}{2\pi r}$ Net magnetic field $B = B_2 - B_1$ $B = \frac{\mu_0 \times 10^2}{20\pi}[10-5]$ $B = \frac{4\pi \times 10^{-7} \times 10^2 \times 5}{20\pi}$ $B = 10^{-5}\,\text{T}$ Along the direction of magnetic field produced by the conductor carrying current 10A.	½ ½ ½ ½	3
24	(i) Defining temperature coefficient 1 (ii) Showing the variation of resistivity 1 (iii) Finding the resistance 1 (i) Change in resistance per unit original resistance per degree change in temperature is temperature coefficient of resistance. (ii)  (**Note:** Please do not deduct marks for not showing values on the graph) (iii) $R_2 = R_1(\theta_2 - \theta_1)\alpha + R_1$ $= 10(-73-27)\times 1.70\times 10^{-4} + 10$ $= -0.170 + 10$ $R_2 = 9.83\,\Omega$ **Alternatively** $R_1 = R_0(1+\alpha t_1)$ $R_2 = R_0(1+\alpha t_2)$ $\frac{R_1}{R_2} = \frac{(1+\alpha t_1)}{(1+\alpha t_2)}$	1 1 ½ ½	

	$R_2 = \frac{(1+\alpha t_1)}{(1+\alpha t_2)} R_1$ $R_2 = \left[\frac{1+1.70\times10^{-4}\times(-73)}{1+1.70\times10^{-4}\times27}\right]\times10$ $R_2 = \frac{0.98759}{1.00459}\times10\ \Omega$ $R_2 = 9.83\ \Omega$	½ ½	3
25	(i) Naming the e.m. wave and writing the wavelength ½ + ½ (ii) Naming the e.m. wave and writing the wavelength ½ + ½ (iii) Naming the e.m. wave and writing the wavelength ½ + ½ (i) Ultraviolet rays Order of wavelength 400 nm – 1 nm (ii) Infrared waves Order of wavelength 1 nm – 700 nm (iii) Radio waves Order of wavelength > 0.1 m	 ½ ½ ½ ½ ½ ½	 3
26	(a) Characteristics of p-n junction diode that makes it suitable for rectification 1 (b) Circuit diagram 1 Explanation of working of full wave rectifier 1 (a) p-n junction diode allows current to pass only when it is forward biased (b)  When input voltage to A, with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative, diode D_1 gets forward biased and conducts while D_2 being reverse biased does not conduct. Hence during this half cycle an output current and output voltage across R_L is obtained. During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage	 1 1	

	at B would be positive. Hence D_1 would not conduct but D_2 would be giving an output current and output voltage. Thus output voltage is obtained during both halves of the cycle.	1	3
27	Explanation of (a), (b) and(c) 1+1+1 (a) Charge of additional charge carriers is just equal and opposite to that of the ionised cores in the lattice. (b) Under equilibrium, the diffusion current is equal to the drift current. (c) Reverse current is limited due to concentration of minority charge carriers on either side of the junction.	1 1 1	 3
28	Finding the radius of circular path 1 Answer for linear path ½ Calculation of linear distance covered 1½ Radius of circular path $r = \frac{mv_x}{eB}$ $r = \frac{9.1\times10^{-31}\times1\times10^{7}}{1.6\times10^{-19}\times0.5\times10^{-3}}$ $= 11.38\times10^{-2}\,\text{m}$ Yes, it traces a linear path too. Linear distance during period of one revolution $y = \frac{2\pi m}{eB}\times v_y$ $= \frac{2\times\pi\times9.1\times10^{-31}\times0.5\times10^{7}}{1.6\times10^{-19}\times0.5\times10^{-3}}$ $= 0.357\,\text{m}$ $= 0.36\ \text{m}$	 ½ ½ ½ ½ ½ ½	 3
	SECTION - D		
29	(i) (C) greater than θ_2 (ii) (C) λ decreases but ν is unchanged (iii) (a) (D) violet colour OR (iii) (b) (C) $r_R < r_Y < r_V$ (iv) (D) undergo total internal reflection	1 1 1 1	 4
30	(i) (D) HCl	1	

	(ii) (B) The net dipole moment of induced dipoles is along the direction of the applied electric field. (iii) (B) decreases and the electric field also decreases. (iv) (a) (C) $\left[\frac{5K}{4K+1}\right]C_0$ **OR** (iv) (b) (D) $\frac{3}{16}$	1 1 1	4
	SECTION - E		
31	(a) (i) Drawing refracted wavefront and Verification of Snell's law 3 (ii) Calculation of distance 2 (i)  Considering triangles ABC and AEC $\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ and ------(1) $\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ ------(2) From equation (1) and equation (2) $\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$ ------(3) If c represents the speed of light in vacuum, then $n_1 = \frac{c}{v_1}$ and $n_2 = \frac{c}{v_2}$ In terms of refractive indices $n_1 \sin i = n_2 \sin r$ which is Snell's law of refraction.	1 ½ ½ ½ ½	

(ii)

$$X_4 = \frac{(2n-1)\lambda D}{2d}$$ ½

$$X_4 = \frac{(2\times 4-1)\times 600\times 10^{-9}\times 1.5}{2\times 0.3\times 10^{-3}}$$ 1

$$= 1.05\times 10^{-2}\ \text{m}$$ ½

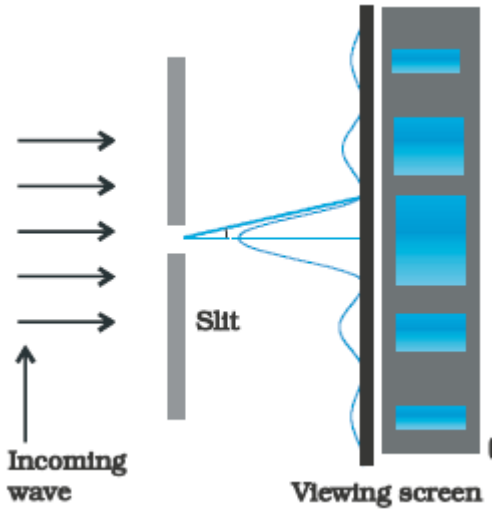
OR

(b)

(i) Brief discussion of Diffraction of light and drawing the shape of diffraction pattern	2+1
(ii) Proof using mirror formula	2

(i) A beam of light falls normally on a single slit and bends around its corners. This phenomenon is called diffraction. 1

When a beam of light falls normally on a narrow single slit, then diffracted light goes on to meet on a screen. It is observed that at the center of the screen intensity is maximum and goes on decreasing as one move away from the center on either side of screen. 1



1

(ii)

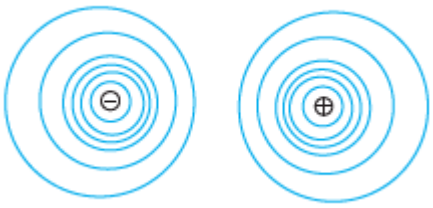
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

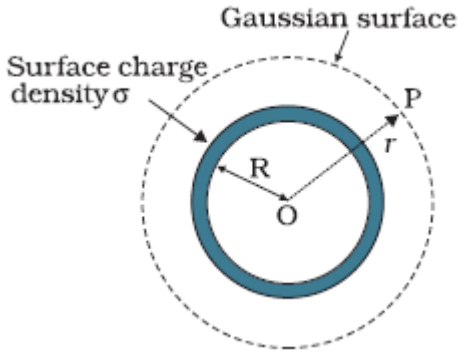
$$v = \frac{uf}{u-f}$$

Following new cartesian sign conversion

$$v = \frac{(-u)(-f)}{-u-(-f)}$$

$$v = \frac{uf}{f-u} \qquad \text{as } f > u$$ 1

	v is +ve, So image is virtual. $m = -\frac{v}{u} = \frac{f}{f-u} > 1$ i.e. Enlarged image	1	5
32	(a) (i) Drawing equipotential surfaces 1 (ii) Obtaining an expression for potential energy 2 (iii) Finding the change in potential energy 2 (i)  (ii) Work done in bringing a charge q_1 from infinity to $\vec{r}_1$: $W_1 = q_1 V(\vec{r}_1)$ ----------(1) Work done in bringing a charge q_2 from infinity to $\vec{r}_2$ against the external field : $W_2 = q_2 V(\vec{r}_2)$ ----------(2) Work done on q_2 against the field due to q_1: $W_{12} = \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}}$ ----------(3) Potential energy of the system = Total work done $= q_1 V(\vec{r}_1) + q_2 V(\vec{r}_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}}$ (iii) Change in Potential energy = Work done $W = pE[\cos\theta_0 - \cos\theta_1]$ $W = 10^{-30} \times 10^5 [\cos 0^0 - \cos 60^0]$ $W = 5.0 \times 10^{-26}$ J **OR** (b) (i) Deduction of an expression for electric field for (i) and (ii) 3 (ii) Finding magnitude and direction of the net electric field 2 **(i)** (i) **Electric Field outside the shell**	1 ½ ½ ½ 1 ½ ½	



½

Electric flux through Gaussian surface

$\Phi = E \times 4\pi r^2$

Charge enclosed by the Gaussian surface

$Q = \sigma \times 4\pi R^2$

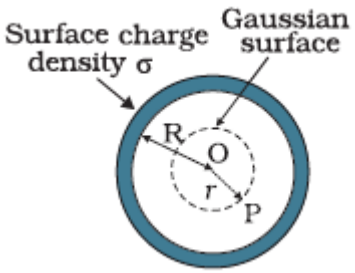
Using Gauss' law: $\int \vec{E}.\vec{ds} = \frac{Q}{\varepsilon_0}$ ½

$E \times 4\pi r^2 = \frac{(\sigma 4\pi R^2)}{\varepsilon_0}$

$\therefore E = \frac{\sigma R^2}{\varepsilon_0 r^2}$ ½

$\vec{E} = \frac{\sigma R^2}{\varepsilon_0 r^2}\hat{r}$

(ii) **Field inside the shell**



½

Electric flux through Gaussian surface

$\Phi = E \times 4\pi r^2 \qquad (\because r < R)$

Charge enclosed by the Gaussian surface

$Q = 0$

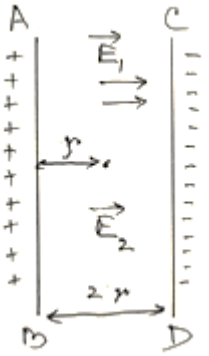
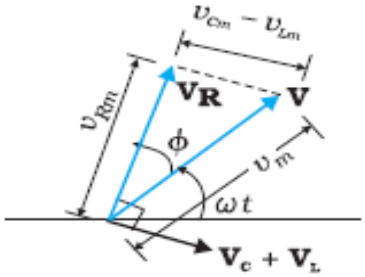
By Gauss' Law

$E \times 4\pi r^2 = 0$ ½

i.e. $E = 0$ ½

(Note: Award full credit of this part if a student writes directly E=0, mentioning as there is no charge enclosed by Gaussian surface)

(ii) Electric field due to a long straight charged wire of linear charged

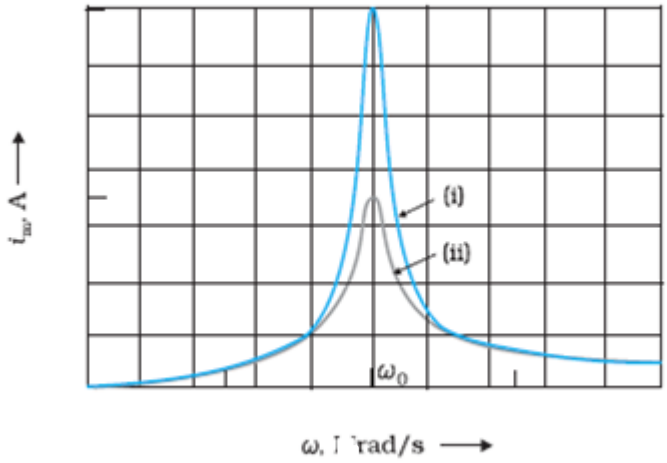
	density λ $E = \frac{\lambda}{2\pi\varepsilon_0 r}$  Net electric field at the mid-point $E_{net} = E_1 + E_2$ $= \frac{\lambda_1}{2\pi\varepsilon_0 r} + \frac{\lambda_2}{2\pi\varepsilon_0 r}$ $E_{net} = \frac{1}{2\pi\varepsilon_0 r}[\lambda_1 + \lambda_2]$ $= \frac{2\times 9\times 10^9}{0.5}[10+20]\times 10^{-6}$ $= 1.08 \times 10^6\ NC^{-1}$ $\vec{E}_{net}$ is directed towards CD.	½ ½ ½ ½	5
33	(a) (i) To identify the circuit element X, Y & Z 1½ (ii) To establish relation for impedance 2 Showing variation in current with frequency ½ (iii) To obtain condition for- (i) Minimum impedance ½ (ii) Wattless current ½ (i) X : Resistor Y : real inductor (such that its reactance is equal to its resistance) / Inductor Z : real capacitor (such that its reactance is equal to its resistance)/ Capacitor (ii)  	½ ½ ½ ½	

From the fig.

$V_m^2 = V_{Rm}^2 + (V_{Cm} - V_{Lm})^2$ ½

$V_m^2 = (i_m R)^2 + (i_m X_C - i_m X_L)^2$ ½

Impedance $(Z) = \frac{V_m}{I_m} = \sqrt{R^2 + (X_C - X_L)^2}$ ½



½

(iii) $Z = \sqrt{R^2 + (X_C - X_L)^2}$

For the minimum value of impedance

(i) $X_C = X_L$ ½

(ii) Average power consumed in A.C. circuit over a cycle

$P = VI \cos \varphi$

For wattless current $P = 0$

Since $V \neq 0$, $I \neq 0$

$\cos \varphi = 0$

i.e. $\varphi = \frac{\pi}{2}$ ½

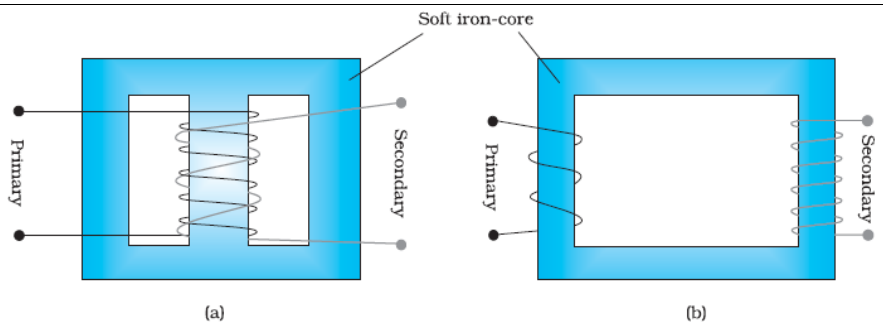
OR

(b)

(i) Description of Construction and working	1+1
Obtaining relation $(\frac{V_S}{V_P})$	1
(ii) Causes of energy losses	2

(i) **Construction:** A transformer consists of two sets of coils, insulated from each other. They are wound on a soft- iron core, either one on top of other or on separate limbs of the core.

Alternatively



1

Working: When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links with the secondary and induces an e.m.f. in it. 1

For an ideal transformer the induced e.m.f. (ε_p) in primary coil for applied alternating voltage (V_P)

$$\varepsilon_p = V_P = -N_P \frac{d\phi}{dt} \quad \text{----------(1)}$$ ½

e.m.f. induced ε_S in the secondary coil

$$\varepsilon_S = V_S = -N_S \frac{d\phi}{dt} \quad \text{----------(2)}$$

From eq. (1) and (2)

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$ ½

(ii) Any four energy losses

1. Flux leakage.
2. Resistance of windings/ copper loss.
3. Eddy currents/iron loss.
4. Hysteresis.
5. Magnetostriction.

$\frac{1}{2} \times 4$ 5

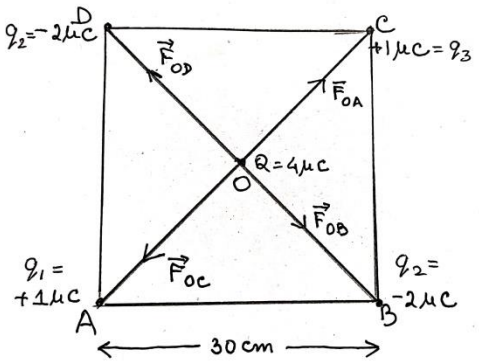
Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT PHYSICS (CODE 55/5/3)

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 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 _____(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.

MARKING SCHEME : PHYSICS (042)			
CODE : 55/5/3			
Q.NO.	**SECTION - A**	**MARKS**	**TOTAL MARKS**
1.	(D) 2P	1	1
2.	(A) $\frac{\mu_0 I}{R}$	1	1
3.	(A) Aluminum	1	1
4.	(A) 0.1Ω	1	1
5.	(B) 5π	1	1
6.	(A) 0.8 fm	1	1
7.	(B) 1.5×10^{16}	1	1
8.	(C) $3.4eV, -6.8eV$	1	1
9.	(B) Ultraviolet rays	1	1
10	(A) A	1	1
11	(D) 125	1	1
12	(D) virtual, at a distance of 3.6 m from the surface.	1	1
13	(C) Assertion (A) is true but Reason (R) is false.	1	1
14	(D) Both Assertion (A) and Reason (R) are false.	1	1
15	(C) Assertion (A) is true but Reason (R) is false.	1	1
16	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).	1	1
	SECTION - B		
17	Deriving an expression for magnetic force 1½ Validity and Justification for zig-zag form conductor ½ Total number of mobile charge carriers in a conductor of length L, cross-sectional area A and number density of charge carriers n: $= nLA$ Force acting on the charge carriers in external magnetic field $\vec{B}$ $\vec{F} = (nAL)q\vec{v}_d \times \vec{B}$ ------(1) Where $\vec{v}_d$ is the drift velocity of the charge carriers Current flowing $I = v_d qnA$ $I\vec{L} = \vec{v}_d qnAL$ ------(2) On solving equation (1) and (2) $\vec{F} = I(\vec{L}\times\vec{B})$ Yes, because this force can be calculated by considering zig-zag conductor as a collection of linear strips $(d\vec{l})$ and summing them vectorically.	½ ½ ½ ½	2
18	(a) Diagram showing direction of forces 1 Finding net force 1		



1

OA = OB = OC = OD = r

Net force on charge $4\mu C$

$\vec{F} = \vec{F}_{OA} + \vec{F}_{OB} + \vec{F}_{OC} + \vec{F}_{OD}$ ½

$\vec{F}_{OA} = -\vec{F}_{OC} \Rightarrow \vec{F}_{OA} + \vec{F}_{OC} = 0$

$\vec{F}_{OB} = -\vec{F}_{OD} \Rightarrow \vec{F}_{OB} + \vec{F}_{OD} = 0$

$\vec{F} = 0$ ½

Alternatively

$$F_{OA} = F_{OC} = \frac{9\times10^{9}\times4\times10^{-6}\times1\times10^{-6}}{(15\sqrt{2}\times10^{-2})^{2}}$$

$= 0.8\,N$

$F_{OB} = F_{OD} = 1.6\ N$ ½

$F_1 = F_{OA} - F_{OC} = 0$

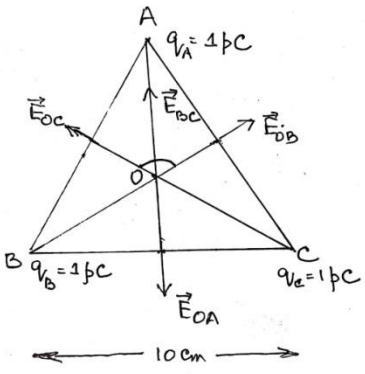
$F_2 = F_{OB} - F_{OD} = 0$

Net Force $F = 0$ ½

OR

(b)

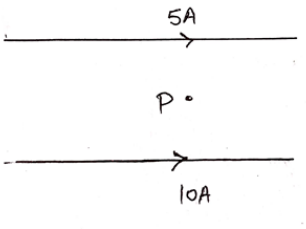
Finding net electric field at centroid	2

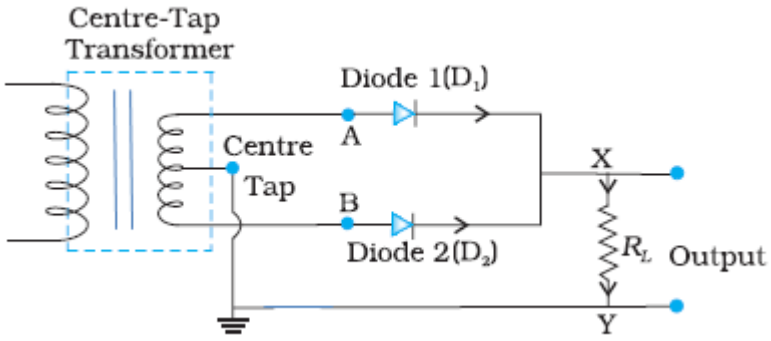


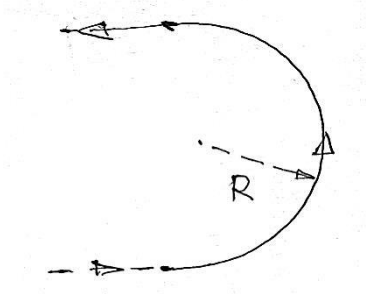
1

	$q_A = q_B = q_C = 1pC$ $AO = BO = CO = r$ $\lvert\vec{E}_{OA}\rvert = \lvert\vec{E}_{OB}\rvert = \lvert\vec{E}_{OC}\rvert$ $\vec{E}_{BC} = \vec{E}_{OB} + \vec{E}_{OC}$ $E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^0}$ $E_{BC} = E_{OB}$, $\vec{E}_{OA} = -\vec{E}_{BC}$ Net electric field $\vec{E}_O = \vec{E}_{OA} + \vec{E}_{BC}$ $\vec{E}_O = 0$ **Alternatively** $E_{OA} = E_{OB} = E_{OC} = 2.7\ NC^{-1}$ $E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^0}$ $= E_{OB}$ *As* $\vec{E}_{BC} = -\vec{E}_{OA}$ $\vec{E}_{BC} + \vec{E}_{OA} = 0$ Net electric field is zero. **Alternatively** $\lvert\vec{E}_{OA}\rvert = \lvert\vec{E}_{OB}\rvert = \lvert\vec{E}_{OC}\rvert$ Electric field vectors are making an angle of 120^0 with each other. They make a closed polygon. So vector sum of all electric field vectors will be zero. $\vec{E} = 0$	½ ½ ½ ½ 2	2
19	Identifying behavior of combination 1 Justification 1 It will behave like a conversing lens. Power of converging lens is more than the power of diverging lens. Hence the combination will behave like a conversing lens. **Alternatively** $P = P_1 + P_2$ $= \frac{100}{10} + \frac{100}{-15}$ $P = \frac{10}{3}\text{D}$ **Alternatively**	1 1	

	$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$ $\frac{1}{f}=\frac{1}{10}-\frac{1}{15}$ $\frac{1}{f}=\frac{1}{30}$ $f=30$ cm		2
20	Calculation of energy released 1 Calculation of time 1 (a) Number of atoms in 2g deuterium $=6.023\times10^{23}$ Energy released /atom $=\frac{3.27}{2}=1.635\,\text{MeV}$ $t=\frac{\text{Total energy released}}{\text{Power}}$ $t=\frac{6.023\times10^{23}\times1.635\times1.6\times10^{-13}}{200}$ $t=7.88\times10^{8}$ s	½ ½ ½ ½	2
21	Calculating frequency of light 2 $v=\frac{v}{2\pi r}$ $v=\frac{2.2\times10^{6}}{2\times\pi\times0.53\times10^{-10}}$ $v=6.6\times10^{15}$ Hz	1 ½ ½	2
	SECTION - C		
22	(a) (i) Statement of Lenz's Law 1 Justification ½ (ii) Calculating emf induced 1½ (i) The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it. In a closed loop, when the polarity of induced emf is such that, the induced current favours the change in magnetic flux then the magnetic flux and consequently the current will go on increasing without any external source of energy. This violets law of conservation of energy.	1 ½	

	(ii) $\varepsilon = \frac{1}{2} Bl^2\omega$ $= \frac{1}{2} \times 2 \times (2)^2 \times (2\pi \times 60)$ $= 480\pi$ V $= 1.51 \times 10^3$ V **OR** (b) (i) Statement and explanation of Ampere's circuital law 1 (ii) Finding magnitude and direction of magnetic field 2 Line integral of magnetic field over a closed loop in vacuum is equal to μ_0 times the total current passing through the loop. **Alternatively** $\oint \vec{B} \cdot \vec{dl} = \mu_0 I$ The integral in this expression is over a closed loop coinciding with the boundary of the surface. (ii)  $B = \frac{\mu_0 I}{2\pi r}$ Net magnetic field $B = B_2 - B_1$ $B = \frac{\mu_0 \times 10^2}{20\pi}[10-5]$ $B = \frac{4\pi \times 10^{-7} \times 10^2 \times 5}{20\pi}$ $B = 10^{-5} T$ Along the direction of magnetic field produced by the conductor carrying current 10A.	½ ½ ½ 1 ½ ½ ½ ½	3
23	(i) Calculation of work function 1 (ii) Calculation of maximum speed 2 (i) $\phi_0 = h\nu_0 = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{14}}{1.6 \times 10^{-19}}$ $= 1.24$ eV	½ ½	

	(ii) $K_{max} = h\nu - h\nu_0$ $\frac{1}{2} m V_{max}^2 = h(\nu - \nu_0)$ $V_{max} = \left[\frac{2h(\nu - \nu_0)}{m}\right]^{\frac{1}{2}}$ $V_{max} = \left[\frac{2\times 6.63\times 10^{-34}(9-3)\times 10^{14}}{9.1\times 10^{-31}}\right]^{\frac{1}{2}}$ $= 9.35\times 10^5$ m/s	½ ½ ½ ½	3
24	(a) Naming the parts of electromagnetic spectrum for (i) and (ii) ½ +½ (b) Writing one method of production and detection of each ½×4 (a) (i) Infrared waves (ii) Ultraviolet Rays (b) Method of production Infrared waves: Hot bodies / Vibration of atoms and molecules Ultraviolet Rays: Special UV lamps / Sun / Very hot bodies Method of detection Infrared waves: Thermopiles / IR photographic film / Bolometer Ultraviolet Rays: Photocells / photographic film	½ ½ ½ ½ ½ ½	3
25	(a) Characteristics of p-n junction diode that makes it suitable for rectification 1 (b) Circuit diagram 1 Explanation of working of full wave rectifier 1 (a) p-n junction diode allows current to pass only when it is forward biased (b)  When input voltage to A, with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative, diode D_1 gets forward biased and conducts while D_2 being reverse biased	1 1	

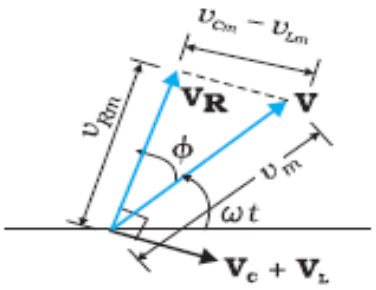
	does not conduct. Hence during this half cycle an output current and output voltage across R_L is obtained. During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive. Hence D_1 would not conduct but D_2 would be giving an output current and output voltage. Thus output voltage is obtained during both halves of the cycle.	1	3
26	Explanation of (a), (b) and(c) 1+1+1 (a) Charge of additional charge carriers is just equal and opposite to that of the ionised cores in the lattice. (b) Under equilibrium, the diffusion current is equal to the drift current. (c) Reverse current is limited due to concentration of minority charge carriers on either side of the junction.	1 1 1	3
27	(a) Calculation for magnetic force and radius 2 (b) Tracing the path 1 (a) $\vec{F}_B = q(\vec{v} \times \vec{B})$ $= -1.6\times10^{-19}\left[(3\times10^{6}\,\hat{i})\times(91\times10^{-3}\hat{k})\right]$ $=1.6\times10^{-19}\left[3\times10^{6}\times91\times10^{-3}\right]\hat{j}$ $= 4.368\times10^{-14}\,\hat{j}$ N $r = \frac{mv}{qB}$ $r = \frac{9.1\times10^{-31}\times3\times10^{6}}{1.6\times10^{-19}\times91\times10^{-3}}$ m $r = 1.875\times10^{-4}$ m (b) Anticlockwise circular path  	½ ½ ½ ½ 1	3
28	(a) Calculating the drift speed $1\frac{1}{2}$ (b) Calculation of Relaxation time $1\frac{1}{2}$		

	(i) $v_d = \dfrac{I}{enA}$ $= \dfrac{4.25}{1.6\times10^{-19}\times8.5\times10^{28}\times10^{-6}}$ m/s $= 3.125\times10^{-4}$ m/s (ii) $\tau = \dfrac{v_d ml}{eV}$ $= \dfrac{3.12\times10^{-4}\times9.1\times10^{-31}\times5}{1.6\times10^{-19}\times1}$ m/s $= 88.72\times10^{-16}$ s $= 8.872\times10^{-15}$ s	½ ½ ½ ½ ½ ½	3
	SECTION - D		
29	(i) (C) greater than θ_2 (ii) (C) λ decreases but ν is unchanged (iii) (a) (D) violet colour OR (iii) (b) (C) $r_R < r_Y < r_V$ (iv) (D) undergo total internal reflection	1 1 1 1	4
30	(i) (D) HCl (ii) (B) The net dipole moment of induced dipoles is along the direction of the applied electric field. (iii) (B) decreases and the electric field also decreases. (iv) (a) (C) $\left[\dfrac{5K}{4K+1}\right]C_0$ **OR** (iv) (b) (D) $\dfrac{3}{16}$	1 1 1 1	4
	SECTION - E		
31	(a) (i) To identify the circuit element X, Y & Z 1½ (ii) To establish relation for impedance 2 Showing variation in current with frequency ½ (iii) To obtain condition for- (i) Minimum impedance ½ (ii) Wattless current ½ (i) X : Resistor Y : real inductor (such that its reactance is equal to its resistance) /	½	

Inductor

Z : real capacitor (such that its reactance is equal to its resistance)/ Capacitor ½

(ii)



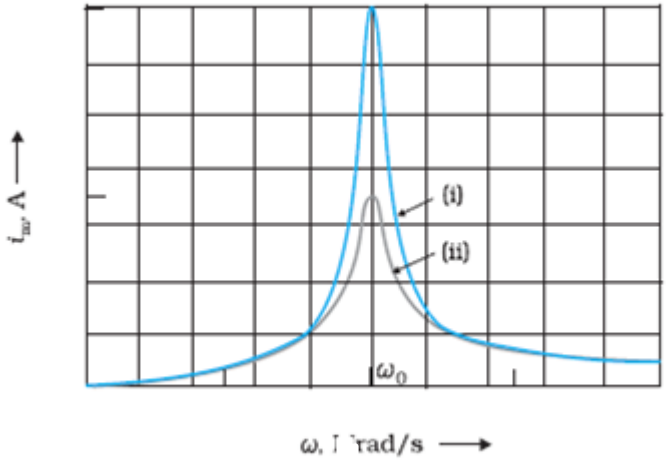
½

From the fig.

$V_m^2 = V_{Rm}^2 + (V_{Cm} - V_{Lm})^2$ ½

$V_m^2 = (i_m \, R)^2 + (i_m X_C - i_m X_L)^2$ ½

Impedance $(Z) = \frac{V_m}{I_m} = \sqrt{R^2 + (X_C - X_L)^2}$ ½



½

(iii) $Z = \sqrt{R^2 + (X_C - X_L)^2}$

For the minimum value of impedance

(i) $X_C = X_L$ ½

(ii) Average power consumed in A.C. circuit over a cycle

$P = VI \cos \varphi$

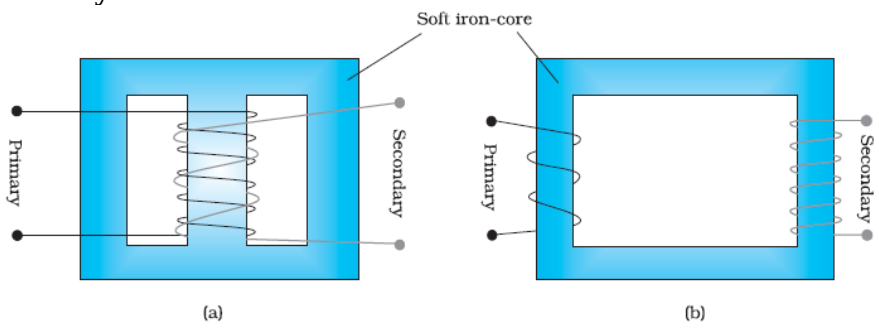
For wattless current $P = 0$

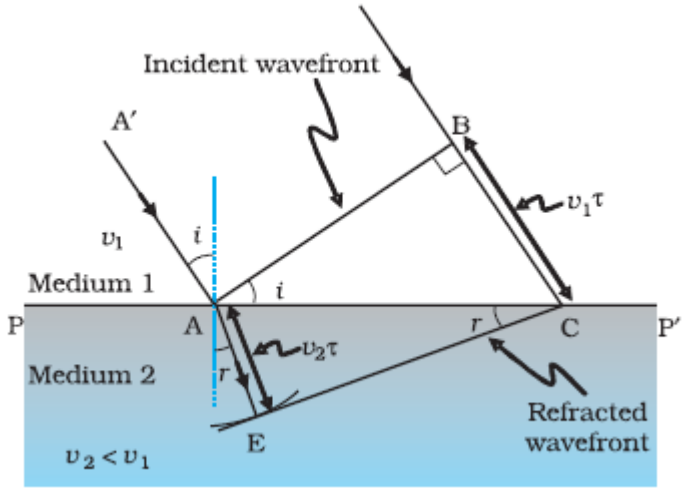
Since $V \neq 0$, $I \neq 0$

$\cos \varphi = 0$

i.e. $\varphi = \frac{\pi}{2}$ ½

OR

	(b) (i) Description of Construction and working 1+1 Obtaining relation ($\frac{V_S}{V_P}$) 1 (ii) Causes of energy losses 2 (i) **Construction:** A transformer consists of two sets of coils, insulated from each other. They are wound on a soft- iron core, either one on top of other or on separate limbs of the core. **Alternatively**  **Working:** When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links with the secondary and induces an e.m.f. in it. For an ideal transformer the induced e.m.f. (ε_p) in primary coil for applied alternating voltage (V_P) $\varepsilon_p = V_P = -N_P \frac{d\phi}{dt}$ ----------(1) e.m.f. induced ε_S in the secondary coil $\varepsilon_S = V_S = -N_S \frac{d\phi}{dt}$ ----------(2) From eq. (1) and (2) $\frac{V_S}{V_P} = \frac{N_S}{N_P}$ (ii) Any four energy losses 1. Flux leakage. 2. Resistance of windings/ copper loss. 3. Eddy currents/iron loss. 4. Hysteresis. 5. Magnetostriction.	1 1 ½ ½ $\frac{1}{2}\times 4$	5
32	(a) (i) Drawing refracted wavefront and Verification of Snell's law 3 (ii) Calculation of distance 2 (i)		



1

Considering triangles ABC and AEC

$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ and ------(1) ½

$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ ------(2)

From equation (1) and equation (2)

$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$ ------(3) ½

If c represents the speed of light in vacuum, then

$n_1 = \frac{c}{v_1}$ and $n_2 = \frac{c}{v_2}$ ½

In terms of refractive indices

$n_1 \sin i = n_2 \sin r$ ½

which is Snell's law of refraction.

(ii)

$X_4 = \frac{(2n-1)\lambda D}{2d}$ ½

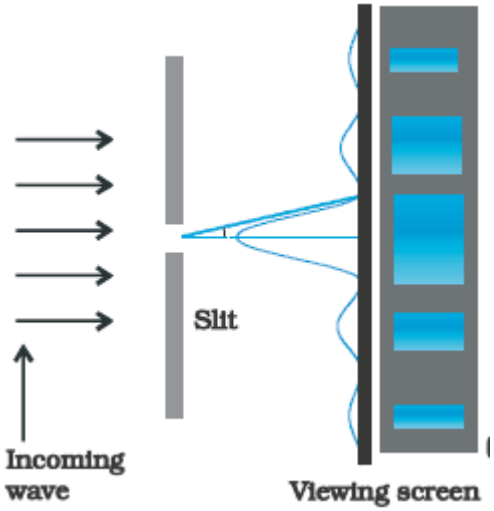
$X_4 = \frac{(2\times 4-1)\times 600\times 10^{-9}\times 1.5}{2\times 0.3\times 10^{-3}}$ 1

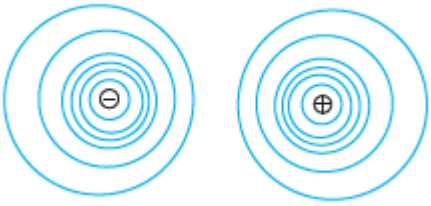
$= 1.05\times 10^{-2}\ m$ ½

OR

(b)

(i) Brief discussion of Diffraction of light and drawing the shape of diffraction pattern	2+1
(ii) Proof using mirror formula	2

	(i) A beam of light falls normally on a single slit and bends around its corners. This phenomenon is called diffraction. When a beam of light falls normally on a narrow single slit, then diffracted light goes on to meet a screen. It is observed that at the center of the screen intensity is maximum and goes on decreasing as one move away from the center on either side of screen.  (ii) $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ $v=\frac{uf}{u-f}$ Following new cartesian sign conversion $v=\frac{(-u)(-f)}{-u-(-f)}$ $v=\frac{uf}{f-u}$ as $f > u$ v is +ve, So image is virtual. $m=-\frac{v}{u}=\frac{f}{f-u}>1$ i.e. Enlarged image	1 1 1 1 1	5
33	(a) (i) Drawing equipotential surfaces 1 (ii) Obtaining an expression for potential energy 2 (iii) Finding the change in potential energy 2 (i)		



1

(ii) Work done in bringing a charge q_1 from infinity to $\vec{r}_1$:

$W_1 = q_1V(\vec{r}_1)$ ----------(1) ½

Work done in bringing a charge q_2 from infinity to $\vec{r}_2$ against the external field :

$W_2 = q_2V(\vec{r}_2)$ ----------(2) ½

Work done on q_2 against the field due to q_1:

$W_{12} = \frac{q_1q_2}{4\pi\varepsilon_0 r_{12}}$ ----------(3) ½

Potential energy of the system = Total work done

$= q_1V(\vec{r}_1) + q_2V(\vec{r}_2) + \frac{q_1q_2}{4\pi\varepsilon_0 r_{12}}$ ½

(iii) Change in Potential energy = Work done 1

$W = pE[\cos\theta_0 - \cos\theta_1]$

$W = 10^{-30} \times 10^5 [\cos 0^0 - \cos 60^0]$ ½

$W = 5.0 \times 10^{-26}$ J ½

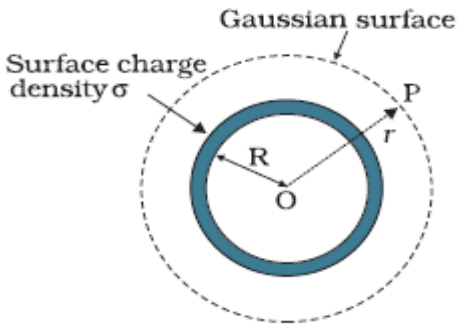
OR

(b)

(i) Deduction of an expression for electric field for (i) and (ii)	3
(ii) Finding magnitude and direction of the net electric field	2

(i)

(i) **Electric Field outside the shell**



½

Electric flux through Gaussian surface

$\Phi = E \times 4\pi r^2$

Charge enclosed by the Gaussian surface

$Q = \sigma \times 4\pi R^2$

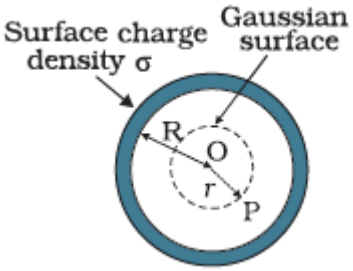
Using Gauss' law: $\int \vec{E}.\overrightarrow{ds} = \frac{Q}{\varepsilon_0}$ ½

$E \times 4\pi r^2 = \frac{(\sigma 4\pi R^2)}{\varepsilon_0}$

$\therefore E = \frac{\sigma R^2}{\varepsilon_0 r^2}$ ½

$\vec{E} = \frac{\sigma R^2}{\varepsilon_0 r^2}\hat{r}$

(ii) **Field inside the shell**



½

Electric flux through Gaussian surface

$\Phi = E \times 4\pi r^2 \qquad (\because r < R)$

Charge enclosed by the Gaussian surface

$Q = 0$

By Gauss' Law

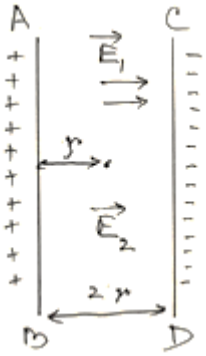
$E \times 4\pi r^2 = 0$ ½

i.e. $E = 0$ ½

(Note: Award full credit of this part if a student writes directly E=0, mentioning as there is no charge enclosed by Gaussian surface)

(ii) Electric field due to a long straight charged wire of linear charged density λ

$E = \frac{\lambda}{2\pi\varepsilon_0 r}$ ½



Net electric field at the mid-point

$E_{net} = E_1 + E_2$

	$= \frac{\lambda_1}{2\pi\varepsilon_0 r} + \frac{\lambda_2}{2\pi\varepsilon_0 r}$ $E_{net} = \frac{1}{2\pi\varepsilon_0 r}[\lambda_1 + \lambda_2]$ $= \frac{2\times 9\times 10^9}{0.5}[10+20]\times 10^{-6}$ $= 1.08 \times 10^6\ NC^{-1}$ $\vec{E}_{net}$ is directed towards CD.	½ ½ ½	5