Series P2QRS/2

Set-2

प्रश्न-पत्र कोड
Q.P. Code **55/2/2**

रोल नं.
Roll No.

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

भौतिक विज्ञान (सैद्धान्तिक)

PHYSICS (Theory)

निर्धारित समय : 3 घण्टे *अधिकतम अंक : 70*

Time allowed : 3 hours *Maximum Marks : 70*

	नोट		NOTE
(I)	कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **27** हैं ।	(I)	Please check that this question paper contains **27** 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 छात्र 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 students will read the question paper only and will not write any answer on the answer-book during this period.

सामान्य निर्देश :

निम्नलिखित निर्देशों को ध्यानपूर्वक पढ़िए और उनका पालन कीजिए :

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

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

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

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

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

(vi) ***खण्ड घ*** *में प्रश्न संख्या* ***29*** *तथा* ***30*** *प्रकरण अध्ययन आधारित प्रश्न हैं । प्रत्येक प्रश्न* ***4*** *अंकों का है ।*

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

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

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

(x) *कैल्कुलेटर का उपयोग **वर्जित** है ।*

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

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

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

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

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

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

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

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

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

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

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

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

General Instructions :

Read the following instructions carefully and follow them :

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

(ii) *This question paper is divided into **five** sections – **Sections A, B, C, D** and **E**.*

(iii) *In **Section A** – Questions no. **1** to **16** are Multiple Choice type questions. Each question carries **1** mark.*

(iv) *In **Section B** – Questions no. **17** to **21** are Very Short Answer type questions. Each question carries **2** marks.*

(v) *In **Section C** – Questions no. **22** to **28** are Short Answer type questions. Each question carries **3** marks.*

(vi) *In **Section D** – Questions no. **29** and **30** are case study based questions. Each question carries **4** marks.*

(vii) *In **Section E** – Questions no. **31** to **33** are Long Answer type questions. Each question carries **5** marks.*

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

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

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

You may use the following values of physical constants wherever necessary :

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

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

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

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

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

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

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

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

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

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

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

खण्ड क

1. किसी समान्तर पट्टिका संधारित्र, जिसकी पट्टिकाओं के बीच परावैद्युतांक $K = 4$ का कोई माध्यम है, की धारिता C है । यदि इस माध्यम को हटा दिया जाए, तो संधारित्र की धारिता होगी :

(A) $4C$ (B) C

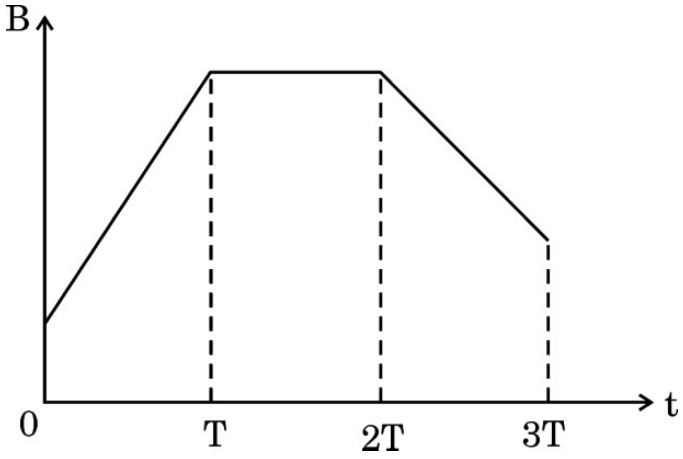
(C) $\frac{C}{4}$ (D) $2C$

2. किसी चालक में जिसके सिरों पर विभवान्तर V है इलेक्ट्रॉनों के अपवाह की चाल v_d है । यदि V घटकर $\left(\frac{V}{2}\right)$ हो जाए, तो अपवाह चाल हो जाएगी :

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

(C) $2\, v_d$ (D) $4\, v_d$

3. कोई चालक पाश, किसी चुम्बकीय क्षेत्र जो इसके तल के अभिलम्बवत है, में स्थित है । आरेख में दर्शाए अनुसार चुम्बकीय क्षेत्र का परिमाण समय के साथ विचरण करता है । यदि समय $0 \le t \le T$, $T \le t \le 2T$ और $2T \le t \le 3T$ पर प्रेरित वि.वा. बल (emf) के परिमाण क्रमश: ε_1, ε_2 और ε_3 हैं, तो :



(A) $\varepsilon_1 > \varepsilon_2 > \varepsilon_3$ (B) $\varepsilon_2 > \varepsilon_3 > \varepsilon_1$

(C) $\varepsilon_3 > \varepsilon_1 > \varepsilon_2$ (D) $\varepsilon_1 > \varepsilon_3 > \varepsilon_2$

4. 10 cm त्रिज्या की कोई वृत्ताकार कुण्डली किसी चुम्बकीय क्षेत्र $\vec{B} = (1{\cdot}0\ \hat{i} + 0{\cdot}5\ \hat{j})$ mT में इस प्रकार रखी है कि कुण्डली के पृष्ठ के अभिलम्बवत बाहर की ओर एकांक सदिश का मान $(0{\cdot}6\ \hat{i} + 0{\cdot}8\ \hat{j})$ है । कुण्डली से संबद्ध चुम्बकीय फ्लक्स है :

(A) $0{\cdot}314\ \mu Wb$ (B) $3{\cdot}14\ \mu Wb$

(C) $31{\cdot}4\ \mu Wb$ (D) $1{\cdot}256\ \mu Wb$

SECTION A

1. The capacitance of a parallel plate capacitor having a medium of dielectric constant K = 4 in between the plates is C. If this medium is removed, then the capacitance of the capacitor becomes :

(A) 4C (B) C

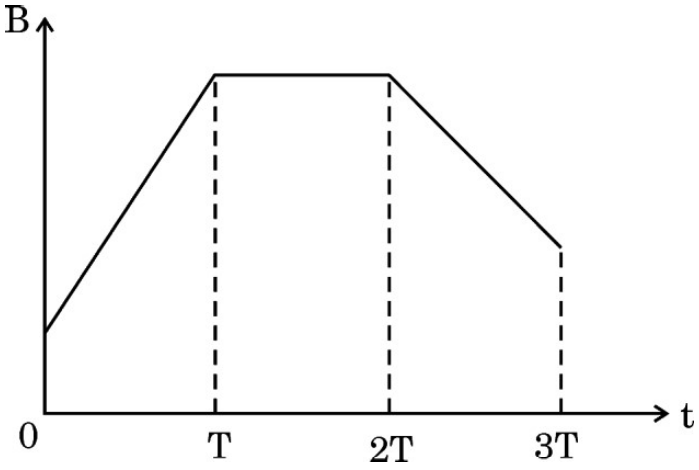
(C) $\frac{C}{4}$ (D) 2C

2. Electrons drift with speed v_d in a conductor with potential difference V across its ends. If V is reduced to $\left(\frac{V}{2}\right)$, their drift speed will become :

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

(C) $2\ v_d$ (D) $4\ v_d$

3. A conducting loop is placed in a magnetic field, normal to its plane. The magnitude of the magnetic field varies with time as shown in the figure. If ε_1, ε_2 and ε_3 are magnitudes of induced emfs during periods $0 \le t \le T$, $T \le t \le 2T$ and $2T \le t \le 3T$, then :



(A) $\varepsilon_1 > \varepsilon_2 > \varepsilon_3$ (B) $\varepsilon_2 > \varepsilon_3 > \varepsilon_1$

(C) $\varepsilon_3 > \varepsilon_1 > \varepsilon_2$ (D) $\varepsilon_1 > \varepsilon_3 > \varepsilon_2$

4. A circular coil of radius 10 cm is placed in a magnetic field $\vec{B} = (1{\cdot}0\ \hat{i} + 0{\cdot}5\ \hat{j})$ mT such that the outward unit vector normal to the surface of the coil is $(0{\cdot}6\ \hat{i} + 0{\cdot}8\ \hat{j})$. The magnetic flux linked with the coil is :

(A) 0·314 μWb (B) 3·14 μWb

(C) 31·4 μWb (D) 1·256 μWb

5. निम्नलिखित में से कौन-सी राशि/राशियाँ किसी आदर्श ट्रान्सफॉर्मर की प्राथमिक और द्वितीयक कुण्डलियों में समान रहती है/हैं ?

विद्युत धारा, वोल्टता, शक्ति, चुम्बकीय फ्लक्स

(A) केवल विद्युत धारा

(B) केवल वोल्टता

(C) केवल शक्ति

(D) चुम्बकीय फ्लक्स और शक्ति दोनों

6. कोई LCR (L = 2 mH, C = 0·2 μF तथा R = 30 Ω) श्रेणी परिपथ परिवर्ती आवृत्ति के किसी ac स्रोत से संयोजित है । किस आवृत्ति के लिए इस परिपथ की प्रतिबाधा न्यूनतम होगी ?

(A) $\frac{10^5}{4\pi}$ Hz

(B) $\frac{10^5}{2\pi}$ Hz

(C) $\frac{10^4}{4\pi}$ Hz

(D) $\frac{10^4}{2\pi}$ Hz

7. वेल्डिंग करने वाले व्यक्ति विशेष काँच का चश्मा या मुखौटा पहनते हैं जिसमें उनके नेत्रों की वेल्डिंग की चिंगारी से उत्पन्न विकिरणों से बचाव के लिए काँच की खिड़की होती है । ये विकिरणें होती हैं :

(A) X-किरणें

(B) पराबैंगनी किरणें

(C) अवरक्त तरंगें

(D) गामा किरणें

8. किसी प्रकाश-सुग्राही पृष्ठ का कार्य-फलन 2·00 eV है । 300 nm तरंगदैर्घ्य के विकिरणों द्वारा पृष्ठ से उत्सर्जित इलेक्ट्रॉनों की अधिकतम गतिज ऊर्जा है :

(A) 0·54 eV

(B) 1·07 eV

(C) 1·61 eV

(D) 2·14 eV

9. किसी परमाणु के ऊर्जा स्तर A, B और C ऊर्जा के बढ़ते हुए मानों अर्थात् $E_A < E_B < E_C$ के तदनुरूप हैं । मान लीजिए संक्रमण C से B, B से A तथा C से A के तदनुरूप विकिरणों के तरंगदैर्घ्य क्रमश: λ_1, λ_2 और λ_3 हैं । तब λ_1, λ_2 और λ_3 के बीच सही संबंध है :

(A) $\lambda_1^2 + \lambda_2^2 = \lambda_3^2$

(B) $\frac{1}{\lambda_1} + \frac{1}{\lambda_2} = \frac{1}{\lambda_3}$

(C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$

(D) $\lambda_1 + \lambda_2 = \lambda_3$

5. Which of the following quantity/quantities remains same in primary and secondary coils of an ideal transformer ?

Current, Voltage, Power, Magnetic flux

(A) Current only

(B) Voltage only

(C) Power only

(D) Magnetic flux and Power both

6. A series LCR circuit (L = 2 mH, C = 0·2 μF and R = 30 Ω) is connected to an ac source of variable frequency. The impedance of this circuit will be minimum at a frequency of :

(A) $\frac{10^5}{4\pi}$ Hz

(B) $\frac{10^5}{2\pi}$ Hz

(C) $\frac{10^4}{4\pi}$ Hz

(D) $\frac{10^4}{2\pi}$ Hz

7. Welders wear special glass goggles or face masks with glass windows to protect their eyes from radiations produced by welding arcs. These radiations are :

(A) X-rays

(B) Ultraviolet rays

(C) Infrared waves

(D) Gamma rays

8. A photosensitive surface has a work function of 2·00 eV. The maximum kinetic energy of electrons ejected from this surface by radiation of wavelength 300 nm is :

(A) 0·54 eV

(B) 1·07 eV

(C) 1·61 eV

(D) 2·14 eV

9. Energy levels A, B and C of an atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$. Let λ_1, λ_2 and λ_3 be the wavelengths of radiation corresponding to the transitions C to B, B to A and C to A, respectively. The correct relation between λ_1, λ_2 and λ_3 is :

(A) $\lambda_1^2 + \lambda_2^2 = \lambda_3^2$

(B) $\frac{1}{\lambda_1} + \frac{1}{\lambda_2} = \frac{1}{\lambda_3}$

(C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$

(D) $\lambda_1 + \lambda_2 = \lambda_3$

10. गाइगर-मार्सडन के किसी प्रयोग में कोई ऐल्फा कण किसी गोल्ड नाभिक पर गतिज ऊर्जा K से उपगमन करता है । यह नाभिक से किसी दूरी d पर क्षणिक रुकता है और अपनी दिशा उत्क्रमित कर लेता है । तब d किसके अनुक्रमानुपाती है ?

(A) $\frac{1}{\sqrt{K}}$ (B) $\sqrt{K}$

(C) $\frac{1}{K}$ (D) K

11. किसी नैज Si को किसके साथ मादित करने पर n-प्रकार का अर्धचालक Si प्राप्त होता है ?

(A) Al (B) B

(C) P (D) In

12. जब किसी p-n संधि डायोड को पश्चदिशिक बायसित किया जाता है, तब :

(A) रोधिका की ऊँचाई घटती है तथा ह्रासी क्षेत्र की चौड़ाई बढ़ जाती है ।

(B) रोधिका की ऊँचाई बढ़ती है तथा ह्रासी क्षेत्र की चौड़ाई बढ़ जाती है ।

(C) रोधिका की ऊँचाई घटती है तथा ह्रासी क्षेत्र की चौड़ाई सिकुड़ जाती है ।

(D) रोधिका की ऊँचाई बढ़ती है तथा ह्रासी क्षेत्र की चौड़ाई सिकुड़ जाती है ।

*प्रश्न संख्या **13** से **16** अभिकथन (A) और कारण (R) प्रकार के प्रश्न हैं । दो कथन दिए गए हैं — जिनमें एक को अभिकथन (A) तथा दूसरे को कारण (R) द्वारा अंकित किया गया है । सही उत्तर नीचे दिए गए कोडों (A), (B), (C) और (D) में से चुनकर दीजिए ।*

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

(B) अभिकथन (A) और कारण (R) दोनों सही हैं, परन्तु कारण (R), अभिकथन (A) की सही व्याख्या ***नहीं*** करता है ।

(C) अभिकथन (A) सही है, परन्तु कारण (R) ग़लत है ।

(D) अभिकथन (A) ग़लत है तथा कारण (R) भी ग़लत है ।

13. *अभिकथन (A) :* किसी संयुक्त सूक्ष्मदर्शी की आवर्धन क्षमता ऋणात्मक होती है ।

कारण (R) : बिम्ब के सापेक्ष अंतिम प्रतिबिम्ब सीधा बनता है ।

10. An alpha particle approaches a gold nucleus in Geiger-Marsden experiment with kinetic energy K. It momentarily stops at a distance d from the nucleus and reverses its direction. Then d is proportional to :

(A) $\frac{1}{\sqrt{K}}$ (B) $\sqrt{K}$

(C) $\frac{1}{K}$ (D) K

11. An n-type semiconducting Si is obtained by doping intrinsic Si with :

(A) Al (B) B

(C) P (D) In

12. When a p-n junction diode is subjected to reverse biasing :

(A) the barrier height decreases and the depletion region widens.

(B) the barrier height increases and the depletion region widens.

(C) the barrier height decreases and the depletion region shrinks.

(D) the barrier height increases and the depletion region shrinks.

*Questions number **13** to **16** are Assertion (A) and Reason (R) type questions. Two statements are given — one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (A), (B), (C) and (D) as given below.*

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not*** the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

13. *Assertion (A) :* The magnifying power of a compound microscope is negative.

Reason (R) : The final image formed is erect with respect to the object.

14. *अभिकथन (A) :* कोई इलेक्ट्रॉन और कोई प्रोटॉन समान संवेग $\vec{p}$ से किसी चुम्बकीय क्षेत्र $\vec{B}$ में इस प्रकार प्रवेश करते हैं कि $\vec{p} \perp \vec{B}$ है । तब ये दोनों समान त्रिज्या के वृत्ताकार पथ पर गमन करते हैं ।

कारण (R) : चुम्बकीय क्षेत्र $\vec{B}$ में गमन करने वाले द्रव्यमान m और आवेश q के आवेशित कण के वृत्ताकार पथ की त्रिज्या, $r = \frac{mv}{qB}$ द्वारा दर्शायी जाती है ।

15. *अभिकथन (A) :* लेंज़ का नियम ऊर्जा संरक्षण नियम का ही एक निष्कर्ष है ।

कारण (R) : किसी आदर्श प्रेरक में शक्ति क्षय नहीं होता है ।

16. *अभिकथन (A) :* आपतित विकिरणों की दी गयी आवृत्ति और त्वरक विभव के लिए प्रकाश-विद्युत धारा के मान में आपतित विकिरणों की तीव्रता में वृद्धि के साथ वृद्धि होती है ।

कारण (R) : आपतित विकिरणों की तीव्रता में वृद्धि के फलस्वरूप प्रति सेकण्ड उत्सर्जित होने वाले प्रकाशिक-इलेक्ट्रॉनों की संख्या में वृद्धि होती है और इस प्रकार प्रकाश-विद्युत धारा में वृद्धि हो जाती है ।

खण्ड ख

17. (क) "किसी दिए गए चालक में कुछ ऐम्पियर परिसर की धाराओं के लिए इलेक्ट्रॉन की अपवाह चाल केवल कुछ mm/s ही होती है ।" फिर परिपथ बन्द करने पर तुरन्त ही उसी क्षण धारा किस प्रकार स्थापित हो जाती है ? व्याख्या कीजिए ।

(ख) 'V = IR ओम के नियम का कोई कथन है' यह सही नहीं है । व्याख्या कीजिए । *2*

18. किसी उत्तल लेंस (n = 1·52) की वायु में फोकस दूरी 15·0 cm है । अपवर्तनांक 1·65 के द्रव में डुबोने पर इस लेंस की फोकस दूरी ज्ञात कीजिए । लेंस की प्रकृति क्या होगी ? *2*

19. (क) दो कलासंबद्ध प्रकाश स्रोतों से निकलने वाली तरंगें, जिनमें प्रत्येक का आयाम 'a' तथा आवृत्ति 'ω' है, किसी बिन्दु पर अध्यारोपण करती हैं । यदि इन दोनों तरंगों के बीच कलान्तर ϕ है, तो इस बिन्दु पर परिणामी तीव्रता के लिए व्यंजक व्युत्पन्न कीजिए । *2*

अथवा

(ख) यंग के द्विझिरी प्रयोग में व्यतिकरण पैटर्न पर क्या प्रभाव होगा जब (i) स्रोत झिरी को झिरियों के तल के निकट लाया जाए, और (ii) झिरियों के बीच पृथक्कन में वृद्धि की जाए ? अपने उत्तरों की पुष्टि कीजिए । *2*

14. *Assertion (A) :* An electron and a proton enter with the same momentum $\vec{p}$ in a magnetic field $\vec{B}$ such that $\vec{p} \perp \vec{B}$. Then both describe a circular path of the same radius.

Reason (R) : The radius of the circular path described by the charged particle (charge q, mass m) moving in the magnetic field $\vec{B}$ is given by $r = \frac{mv}{qB}$.

15. *Assertion (A) :* Lenz's law is a consequence of the law of conservation of energy.

Reason (R) : There is no power loss in an ideal inductor.

16. *Assertion (A) :* Photoelectric current increases with an increase in intensity of incident radiation, for a given frequency of incident radiation and the accelerating potential.

Reason (R) : Increase in the intensity of incident radiation results in an increase in the number of photoelectrons emitted per second and hence an increase in the photocurrent.

SECTION B

17. (a) "The electron drift speed is only a few mm/s for currents in the range of a few amperes for a given conductor." How then is current established almost the instant a circuit is closed ? Explain.

(b) 'V = IR is a statement of Ohm's Law' is not true. Explain. *2*

18. A convex lens (n = 1·52) has a focal length of 15·0 cm in air. Find its focal length when it is immersed in liquid of refractive index 1·65. What will be the nature of the lens ? *2*

19. (a) Two waves, each of amplitude 'a' and frequency 'ω' emanating from two coherent sources of light superpose at a point. If the phase difference between the two waves is ϕ, obtain an expression for the resultant intensity at that point. *2*

OR

(b) What is the effect on the interference pattern in Young's double-slit experiment when (i) the source slit is moved closer to the plane of the slits, and (ii) the separation between the two slits is increased ? Justify your answers. *2*

20. निम्नलिखित नाभिकीय अभिक्रिया में निर्मुक्त/अवशोषित ऊर्जा परिकलित कीजिए : *2*

$$^{12}_{6}C + ^{12}_{6}C \longrightarrow ^{20}_{10}Ne + ^{4}_{2}He$$

दिया गया है : $m\left(^{12}_{6}C\right) = 12{\cdot}000000\ u$

$m\left(^{20}_{10}Ne\right) = 19{\cdot}992439\ u$

$m\left(^{4}_{2}He\right) = 4{\cdot}002603\ u$

$1\ u = 931\ MeV/c^2$

21. किसी नैज अर्धचालक के ऊर्जा अन्तराल में क्या प्रभावी अन्तर होता है जब उसे अपमिश्रित किया जाता है : (क) त्रिसंयोजी अपद्रव्य के साथ, और (ख) पंचसंयोजी अपद्रव्य के साथ ? प्रत्येक स्थिति में अपने उत्तर की पुष्टि कीजिए । *2*

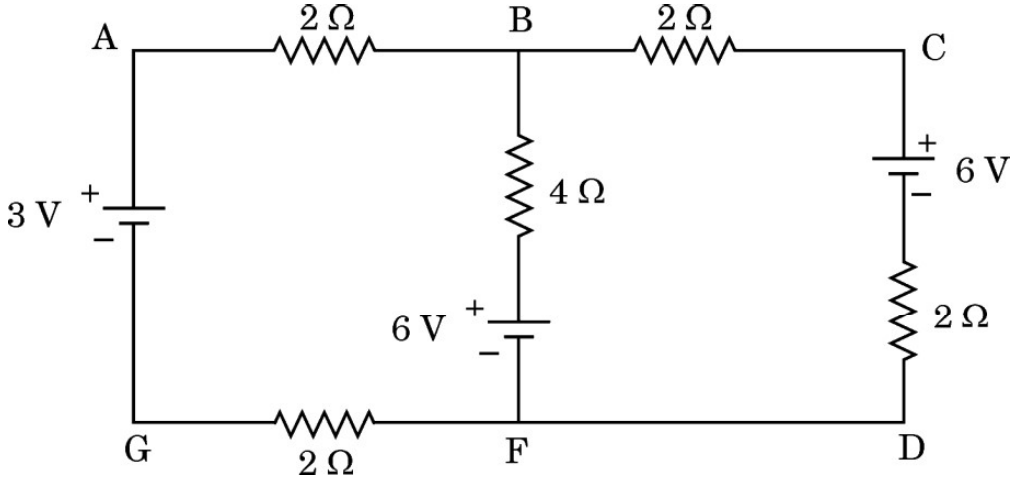
खण्ड ग

22. (क) किसी माध्यम में विद्युत-चुम्बकीय तरंग की चाल किन कारकों पर निर्भर करती है ?

(ख) कोई विद्युत-चुम्बकीय तरंग किस प्रकार उत्पन्न की जाती है ?

(ग) z-अक्ष के अनुदिश संचरण करती किसी विद्युत-चुम्बकीय तरंग का व्यवस्था आरेख विद्युत और चुम्बकीय क्षेत्रों को चित्रित करते हुए खींचिए । *3*

23. आरेख में तीन आदर्श बैटरियों के साथ विद्युत परिपथ दर्शाया गया है । इसकी शाखाओं AG, BF और CD में विद्युत धाराओं के परिमाण और दिशाएँ ज्ञात कीजिए । *3*



20. Calculate the energy released/absorbed in the following nuclear reaction : *2*

$$^{12}_{6}C + ^{12}_{6}C \longrightarrow ^{20}_{10}Ne + ^{4}_{2}He$$

Given : $m\left(^{12}_{6}C\right) = 12{\cdot}000000$ u

$m\left(^{20}_{10}Ne\right) = 19{\cdot}992439$ u

$m\left(^{4}_{2}He\right) = 4{\cdot}002603$ u

1 u $= 931$ MeV/c^2

21. How does the energy gap of an intrinsic semiconductor effectively change when doped with a (a) trivalent impurity, and (b) pentavalent impurity ? Justify your answer in each case. *2*

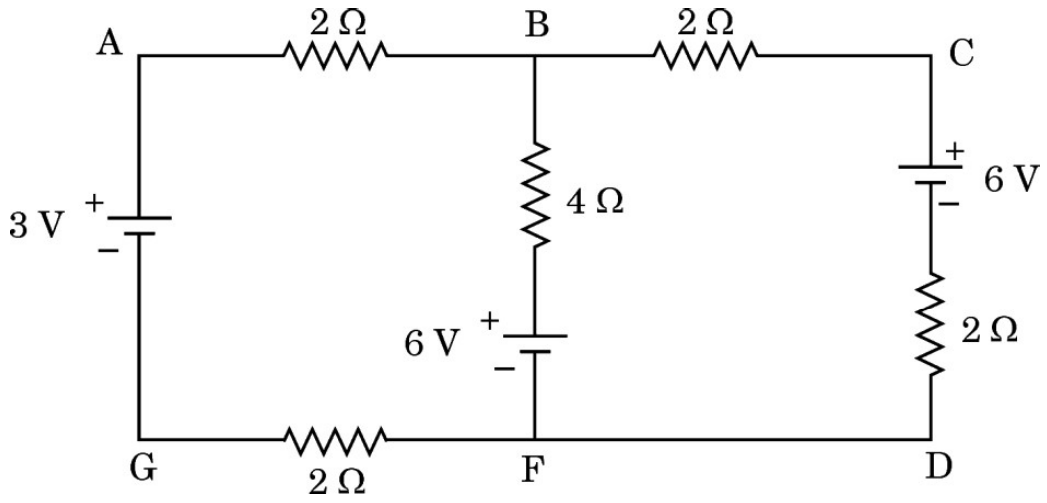
SECTION C

22. (a) On what factors does the speed of an electromagnetic wave in a medium depend ?

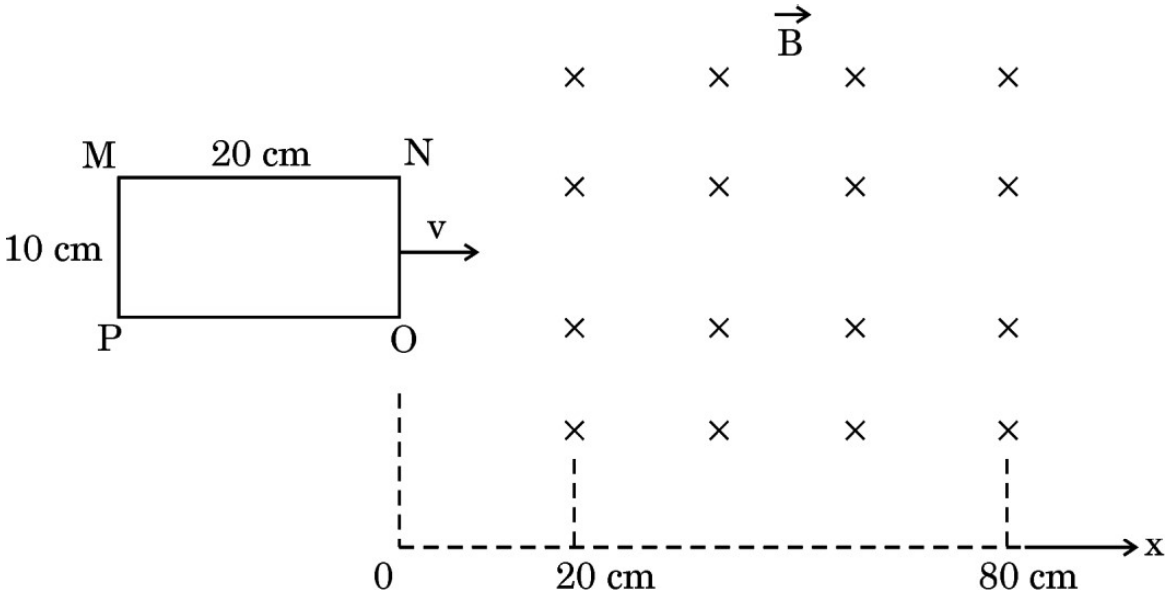
(b) How is an electromagnetic wave produced ?

(c) Sketch a schematic diagram depicting the electric and magnetic fields for an electromagnetic wave propagating along z-axis. *3*

23. The figure shows a circuit with three ideal batteries. Find the magnitude and direction of currents in the branches AG, BF and CD. *3*



24. आरेख में दर्शाए अनुसार 10 cm × 20 cm भुजाओं का कोई आयताकार पाश एकसमान चुम्बकीय क्षेत्र $|\vec{B}| = 5$ mT के प्रदेश के बाहर रखा है । इस पाश को 5 cm/s के वेग से तब तक गति कराई जाती है जब तक कि यह पूर्णत: चुम्बकीय क्षेत्र से बाहर नहीं चला जाता ।



(क) x ($0 \leq x \leq 100$ cm) के साथ चुम्बकीय फ्लक्स ϕ के विचरण को दर्शाने के लिए ग्राफ खींचिए ।

(ख) पाश से संबद्ध चुम्बकीय फ्लक्स का अधिकतम मान ज्ञात कीजिए ।

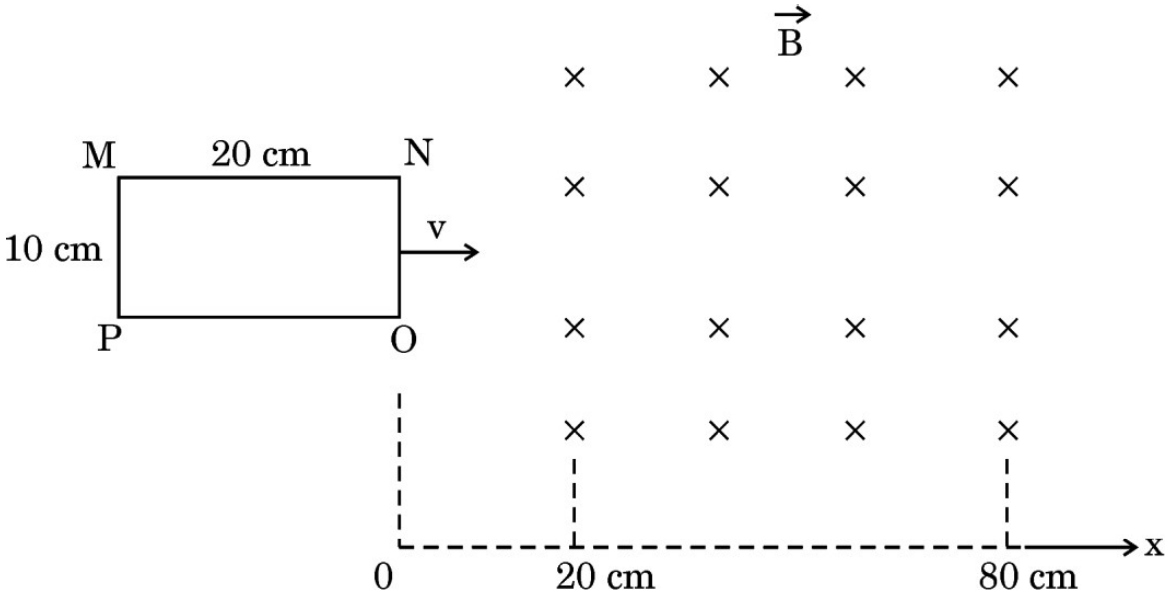
(ग) इस पाश को चुम्बकीय क्षेत्र से होकर गति कराने के लिए क्या किसी बाह्य कार्य की आवश्यकता होगी ? *3*

25. (क) दो लम्बे सीधे समान्तर चालकों से विपरीत दिशाओं में स्थायी धाराएँ प्रवाहित हो रही हैं । इन दोनों चालकों के बीच अन्योन्य बल की प्रकृति की व्याख्या कीजिए । दोनों चालकों के बीच बल के परिमाण के लिए व्यंजक प्राप्त कीजिए और इस प्रकार एक ऐम्पियर की परिभाषा दीजिए । *3*

अथवा

(ख) किसी एकसमान चुम्बकीय क्षेत्र $\vec{B}$ में स्थित किसी धारावाही पाश पर कार्यरत बल-आघूर्ण $\vec{\tau}$ के लिए व्यंजक प्राप्त कीजिए । आवश्यक आरेख भी खींचिए । *3*

24. A rectangular loop of sides 10 cm × 20 cm is kept outside a region of uniform magnetic field $|\vec{B}|$ = 5 mT as shown in the figure. The loop is moved with the velocity of 5 cm/s till it goes completely out of the magnetic field.



(a) Plot a graph showing variation of the magnetic flux ϕ with x ($0 \leq x \leq 100$ cm).

(b) Find the maximum value of magnetic flux linked with the loop.

(c) Will an external work be required to be done to move the loop through the magnetic field ? *3*

25. (a) Two long, straight, parallel conductors carry steady currents in opposite directions. Explain the nature of the force of interaction between them. Obtain an expression for the magnitude of the force between the two conductors. Hence define one ampere. *3*

OR

(b) Obtain an expression for the torque $\vec{\tau}$ acting on a current carrying loop in a uniform magnetic field $\vec{B}$. Draw the necessary diagram. *3*

26. (क) द्रव्य की तरंग प्रकृति के लिए दे ब्रॉग्ली परिकल्पना की संक्षेप में व्याख्या कीजिए ।

(ख) किसी प्रोटॉन और किसी ऐल्फा कण से संबद्ध दे ब्रॉग्ली तरंगदैर्घ्य का अनुपात ज्ञात कीजिए जब

(i) दोनों को समान विभवान्तर द्वारा विराम से त्वरित किया गया है, तथा

(ii) दोनों समान गतिज ऊर्जा से गतिमान हैं । *3*

27. (क) किसी नाभिक में न्यूक्लिऑनों के युगल की स्थितिज ऊर्जा को उनके पृथक्कन के फलन के रूप में चित्रित करते हुए ग्राफ खींचिए ।

(ख) उन प्रदेशों को पहचानिए जहाँ नाभिकीय बल (i) आकर्षी, तथा (ii) प्रतिकर्षी है । अपने उत्तर की पुष्टि कीजिए । *3*

28. परिपथ आरेख की सहायता से किसी p-n संधि डायोड की पूर्ण तरंग दिष्टकारी के रूप में कार्यविधि की व्याख्या कीजिए । इसके निवेशी और निर्गत तरंगरूप भी खींचिए । *3*

खण्ड घ
प्रकरण अध्ययन आधारित प्रश्न

*प्रश्न संख्या **29** तथा **30** प्रकरण अध्ययन आधारित प्रश्न हैं । निम्नलिखित अनुच्छेदों को पढ़ कर दिए गए प्रश्नों के उत्तर दीजिए ।*

29. जब कोई प्रकाश की किरण सघन माध्यम से विरल माध्यम में संचरण करती है, तो वह अभिलम्ब से दूर मुड़ जाती है । जब आपतन कोण में वृद्धि करते हैं, तो अपवर्तित किरण अभिलम्ब से और अधिक मुड़ती जाती है । सघन माध्यम में किसी विशेष आपतन कोण के लिए अपवर्तित किरण दोनों माध्यमों के अन्तरापृष्ठ को ठीक-ठीक स्पर्श करती है । इस आपतन कोण को सम्मिलित माध्यमों के युगल (जोड़े) के लिए क्रांतिक कोण कहते हैं ।

(i) क्रांतिक कोण पर आपतन करने वाली किरण के लिए परावर्तन कोण का मान होता है : *1*

(A) $0°$ (B) $< 90°$

(C) $> 90°$ (D) $90°$

(ii) जल $\left(n = \frac{4}{3}\right)$ में गमन करती कोई 600 nm तरंगदैर्घ्य की प्रकाश किरण जल-वायु अन्तरापृष्ठ पर क्रांतिक कोण से कम कोण पर आपतन करती है । अपवर्तित किरण से संबद्ध तरंगदैर्घ्य है : *1*

(A) 400 nm (B) 450 nm

(C) 600 nm (D) 800 nm

26. (a) Briefly explain de Broglie hypothesis for wave nature of matter.

(b) Find the ratio of de Broglie wavelength associated with a proton and an alpha particle when both are

(i) accelerated from rest through the same potential difference, and

(ii) moving with the same kinetic energy. *3*

27. (a) Plot a graph depicting potential energy of a pair of nucleons in a nucleus as a function of their separation.

(b) Identify the regions where the nuclear force is (i) attractive, and (ii) repulsive. Justify your answer. *3*

28. With the help of a circuit diagram, explain the working of a p-n junction diode as a full wave rectifier. Draw its input and output waveforms. *3*

SECTION D
Case Study Based Questions

*Questions number **29** and **30** are case study based questions. Read the following paragraphs and answer the questions that follow.*

29. When a ray of light propagates from a denser medium to a rarer medium, it bends away from the normal. When the incident angle is increased, the refracted ray deviates more from the normal. For a particular angle of incidence in the denser medium, the refracted ray just grazes the interface of the two surfaces. This angle of incidence is called the critical angle for the pair of media involved.

(i) For a ray incident at the critical angle, the angle of reflection is : *1*

(A) 0° (B) $< 90°$

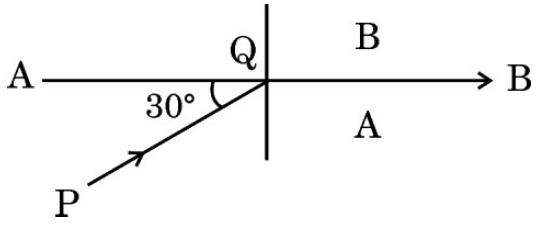
(C) $> 90°$ (D) 90°

(ii) A ray of light of wavelength 600 nm is incident in water $\left(n = \frac{4}{3}\right)$ on the water-air interface at an angle less than the critical angle. The wavelength associated with the refracted ray is : *1*

(A) 400 nm (B) 450 nm

(C) 600 nm (D) 800 nm

(iii) (क) आरेख में दो माध्यमों A और B के बीच अन्तरापृष्ठ AB को दर्शाया गया है । सघन माध्यम A में, आपतित किरण PQ क्षैतिज से 30° का कोण बनाती है । अपवर्तित किरण अन्तरापृष्ठ के समान्तर है । माध्यम A के सापेक्ष माध्यम B का अपवर्तनांक है : *1*



(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{\sqrt{5}}{2}$

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

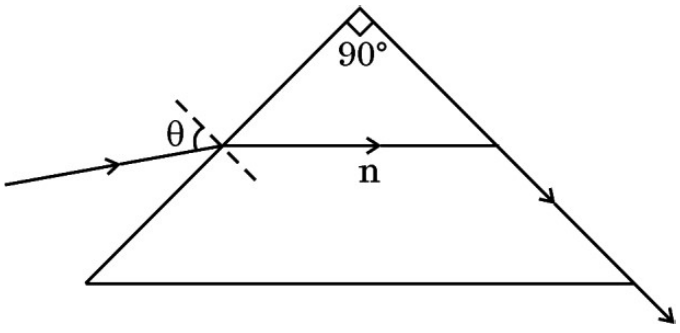
अथवा

(ख) दो माध्यम A और B किसी समतल सीमा द्वारा पृथक्कित हैं । A और B माध्यम में प्रकाश की चाल क्रमश: 2×10^8 ms^{-1} और $2{\cdot}5 \times 10^8$ ms^{-1} है । माध्यम A से माध्यम B में गमन करने वाली प्रकाश की किरण के लिए क्रांतिक कोण है : *1*

(A) $\sin^{-1}\frac{1}{2}$ (B) $\sin^{-1}\frac{4}{5}$

(C) $\sin^{-1}\frac{3}{5}$ (D) $\sin^{-1}\frac{2}{5}$

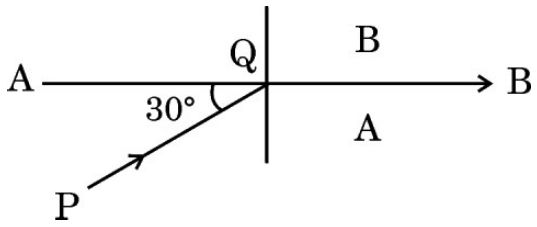
(iv) आरेख में किसी त्रिभुजाकार प्रिज़्म से गमन करती किसी प्रकाश की किरण का पथ दर्शाया गया है । इस परिघटना में कोण θ का मान है : *1*



(A) $\sin^{-1}\sqrt{n^2-1}$ (B) $\sin^{-1}(n^2-1)$

(C) $\sin^{-1}\left[\frac{1}{\sqrt{n^2-1}}\right]$ (D) $\sin^{-1}\left[\frac{1}{(n^2-1)}\right]$

(iii) (a) The interface AB between the two media A and B is shown in the figure. In the denser medium A, the incident ray PQ makes an angle of 30° with the horizontal. The refracted ray is parallel to the interface. The refractive index of medium B w.r.t. medium A is : *1*



(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{\sqrt{5}}{2}$

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

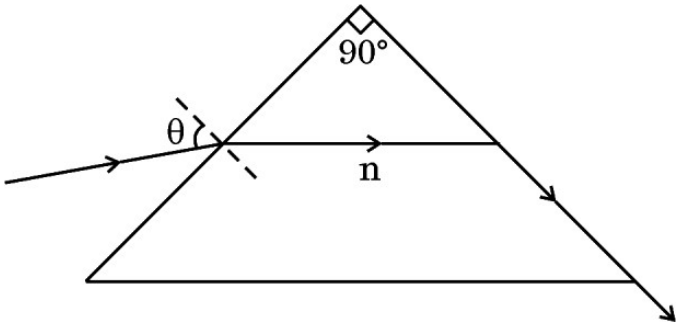
OR

(b) Two media A and B are separated by a plane boundary. The speed of light in medium A and B is 2×10^8 ms^{-1} and $2{\cdot}5 \times 10^8$ ms^{-1} respectively. The critical angle for a ray of light going from medium A to medium B is : *1*

(A) $\sin^{-1}\frac{1}{2}$ (B) $\sin^{-1}\frac{4}{5}$

(C) $\sin^{-1}\frac{3}{5}$ (D) $\sin^{-1}\frac{2}{5}$

(iv) The figure shows the path of a light ray through a triangular prism. In this phenomenon, the angle θ is given by : *1*



(A) $\sin^{-1}\sqrt{n^2-1}$ (B) $\sin^{-1}(n^2-1)$

(C) $\sin^{-1}\left[\frac{1}{\sqrt{n^2-1}}\right]$ (D) $\sin^{-1}\left[\frac{1}{(n^2-1)}\right]$

30. जब किसी सेल के टर्मिनलों को किसी R प्रतिरोध के चालक से संयोजित किया जाता है, तो परिपथ से विद्युत धारा प्रवाहित होती है । सेल का विद्युत-अपघट्य भी धारा के पथ में चालक की भाँति कुछ प्रतिरोध लगाता है । विद्युत-अपघट्य द्वारा लगाए गए इस प्रतिरोध को सेल का आन्तरिक प्रतिरोध (r) कहते हैं । यह प्रतिरोध विद्युत-अपघट्य की प्रकृति, विद्युत-अपघट्य में इलेक्ट्रोडों के डूबे हुए क्षेत्रफल तथा ताप पर निर्भर करता है । आन्तरिक प्रतिरोध के कारण सेल द्वारा आपूर्त ऊर्जा का कुछ भाग ऊष्मा के रूप में नष्ट हो जाता है ।

जब सेल से कोई धारा नहीं ली जा रही होती है, तो उसके दो इलेक्ट्रोडों के बीच विभवान्तर को सेल का वि.वा. बल (emf) (ε) कहते हैं । सेल से धारा लेते समय दो इलेक्ट्रोडों के बीच विभवान्तर को टर्मिनल विभवान्तर (V) कहते हैं ।

(i) ***असत्य*** कथन चुनिए : *1*

(A) सेल को अनावेशित करते समय बन्द परिपथ में किसी सेल के दो टर्मिनलों के बीच विभवान्तर (V), सेल के वि.वा. बल (emf) (ε) से सदैव कम होता है ।

(B) विद्युत-अपघट्य का ताप घटने पर सेल का आन्तरिक प्रतिरोध घट जाता है ।

(C) सेल से धारा लेते समय $V = \varepsilon - Ir$ होता है ।

(D) सेल के दो टर्मिनलों के बीच विभवान्तर (V) और इससे प्रवाहित धारा (I) के बीच ग्राफ सरल रेखा होता है जिसकी प्रवणता ऋणात्मक होती है ।

(ii) 2·0 V और 6·0 V वि.वा. बल (emf) वाले दो सेल, जिनके आन्तरिक प्रतिरोध क्रमशः 0·1 Ω और 0·4 Ω हैं, पार्श्व में संयोजित हैं । इस संयोजन का तुल्य वि.वा. बल (emf) होगा : *1*

(A) 2·0 V (B) 2·8 V

(C) 6·0 V (D) 8·0 V

(iii) विलयन में डूबे हुए इलेक्ट्रोड विद्युत-अपघट्य से आवेशों का आदान-प्रदान करते हैं । अपने से संलग्न विद्युत-अपघट्य के सापेक्ष धनात्मक इलेक्ट्रोड का विभव V_+ ($V_+ > 0$) तथा ऋणात्मक इलेक्ट्रोड का विभव $-(V_-)$ ($V_- \geq 0$) हो जाता है । जब सेल से कोई धारा नहीं ली जा रही होती है, तब *1*

(A) $\varepsilon = V_+ + V_- > 0$ (B) $\varepsilon = V_+ - V_- > 0$

(C) $\varepsilon = V_+ + V_- < 0$ (D) $\varepsilon = V_+ + V_- = 0$

30. When the terminals of a cell are connected to a conductor of resistance R, an electric current flows through the circuit. The electrolyte of the cell also offers some resistance in the path of the current, like the conductor. This resistance offered by the electrolyte is called internal resistance of the cell (r). It depends upon the nature of the electrolyte, the area of the electrodes immersed in the electrolyte and the temperature. Due to internal resistance, a part of the energy supplied by the cell is wasted in the form of heat.

When no current is drawn from the cell, the potential difference between the two electrodes in known as emf of the cell (ε). With a current drawn from the cell, the potential difference between the two electrodes is termed as terminal potential difference (V).

(i) Choose the ***incorrect*** statement : *1*

(A) The potential difference (V) between the two terminals of a cell in a closed circuit is always less than its emf (ε), during discharge of the cell.

(B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte.

(C) When current is drawn from the cell then $V = \varepsilon - Ir$.

(D) The graph between potential difference between the two terminals of the cell (V) and the current (I) through it is a straight line with a negative slope.

(ii) Two cells of emfs 2·0 V and 6·0 V and internal resistances 0·1 Ω and 0·4 Ω respectively, are connected in parallel. The equivalent emf of the combination will be : *1*

(A) 2·0 V (B) 2·8 V

(C) 6·0 V (D) 8·0 V

(iii) Dipped in the solution, the electrode exchanges charges with the electrolyte. The positive electrode develops a potential V_+ ($V_+ > 0$), and the negative electrode develops a potential $-(V_-)$ ($V_- \geq 0$), relative to the electrolyte adjacent to it. When no current is drawn from the cell then : *1*

(A) $\varepsilon = V_+ + V_- > 0$ (B) $\varepsilon = V_+ - V_- > 0$

(C) $\varepsilon = V_+ + V_- < 0$ (D) $\varepsilon = V_+ + V_- = 0$

(iv) (क) 2 V वि.वा. बल (emf) और 0·1 Ω आन्तरिक प्रतिरोध के पाँच सर्वसम सेलों को पार्श्व में संयोजित किया गया है । इस संयोजन को फिर 9·98 Ω के बाह्य प्रतिरोधक से संयोजित किया गया है । प्रतिरोधक से प्रवाहित धारा है : *1*

(A) 0·05 A (B) 0·1 A

(C) 0·15 A (D) 0·2 A

अथवा

(ख) खुले परिपथ में किसी सेल के सिरों पर विभवान्तर 6 V है । 2 A विद्युत धारा लेने पर यह विभवान्तर 4 V हो जाता है । सेल का आन्तरिक प्रतिरोध है : *1*

(A) 1·0 Ω (B) 1·5 Ω

(C) 2·0 Ω (D) 2·5 Ω

खण्ड ङ

31. (क) (i) यंग के द्विझिरी प्रयोग के व्यतिकरण पैटर्न और एकल झिरी के कारण विवर्तन पैटर्न के बीच कोई दो अन्तर दीजिए ।

(ii) द्विझिरी व्यतिकरण पैटर्न के प्रकरण में तीव्रता वितरण ग्राफ खींचिए ।

(iii) तरंगदैर्घ्य λ के एकवर्णीय प्रकाश का उपयोग करने पर यंग के द्विझिरी प्रयोग में पर्दे के जिस बिन्दु पर पथान्तर λ है, वहाँ प्रकाश की तीव्रता K मात्रक है । पर्दे के जिस बिन्दु पर पथान्तर $\frac{\lambda}{6}$ है, वहाँ प्रकाश की तीव्रता ज्ञात कीजिए । *5*

अथवा

(ख) (i) किसी संयुक्त सूक्ष्मदर्शी द्वारा स्पष्ट दर्शन की न्यूनतम दूरी पर प्रतिबिम्ब बनना दर्शाने के लिए नामांकित किरण आरेख खींचिए । इसकी आवर्धन क्षमता के लिए व्यंजक व्युत्पन्न कीजिए ।

(ii) कोई दूरदर्शी (दूरबीन) 100 cm और 5 cm फोकस दूरी के दो लेंसों से मिलकर बना है । उस स्थिति में इसकी आवर्धन क्षमता ज्ञात कीजिए जिसमें अंतिम प्रतिबिम्ब अनन्त पर बनता है । *5*

(iv) (a) Five identical cells, each of emf 2 V and internal resistance 0·1 Ω are connected in parallel. This combination in turn is connected to an external resistor of 9·98 Ω. The current flowing through the resistor is : *1*

(A) 0·05 A (B) 0·1 A

(C) 0·15 A (D) 0·2 A

OR

(b) Potential difference across a cell in the open circuit is 6 V. It becomes 4 V when a current of 2 A is drawn from it. The internal resistance of the cell is : *1*

(A) 1·0 Ω (B) 1·5 Ω

(C) 2·0 Ω (D) 2·5 Ω

SECTION E

31. (a) (i) Give any two differences between the interference pattern obtained in Young's double-slit experiment and a diffraction pattern due to a single slit.

(ii) Draw an intensity distribution graph in case of a double-slit interference pattern.

(iii) In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen, where path difference is λ, is K units. Find the intensity of light at a point on the screen where the path difference is $\frac{\lambda}{6}$. *5*

OR

(b) (i) Draw a labelled ray diagram of a compound microscope showing image formation at least distance of distinct vision. Derive an expression for its magnifying power.

(ii) A telescope consists of two lenses of focal length 100 cm and 5 cm. Find the magnifying power when the final image is formed at infinity. *5*

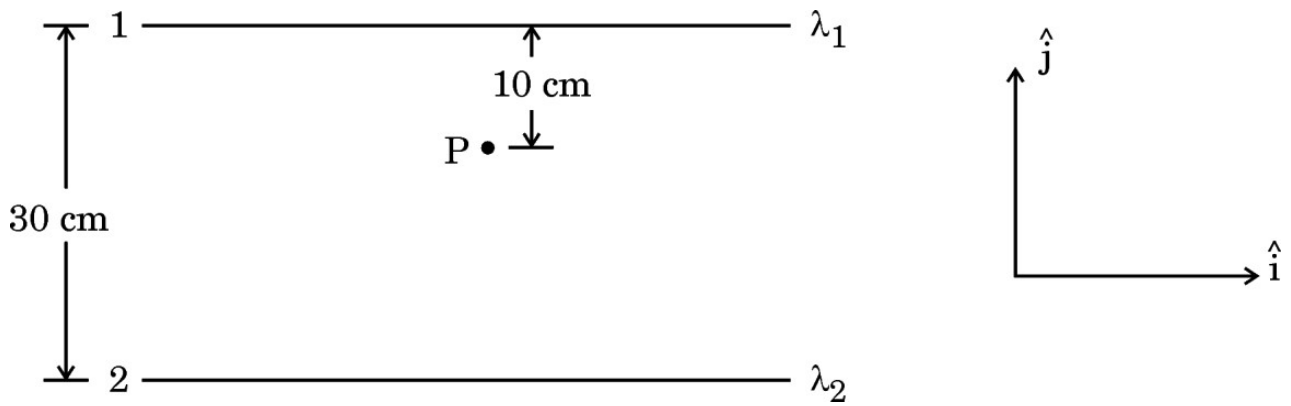
32. (क) (i) द्विध्रुव आघूर्ण $\vec{p}$ के किसी लघु द्विध्रुव के कारण, द्विध्रुव के साइज की तुलना में उसके केन्द्र से बहुत अधिक दूरी पर स्थित किसी बिन्दु $\vec{r}$ पर, विद्युत विभव के लिए व्यंजक प्राप्त कीजिए ।

(ii) किसी समबाहु त्रिभुज के शीर्षों पर तीन बिन्दु आवेश q, 2q और nq स्थित हैं । यदि इस निकाय की स्थितिज ऊर्जा शून्य है, तो n का मान ज्ञात कीजिए । *5*

अथवा

(ख) (i) स्थिरवैद्युतिकी का गाउस नियम लिखिए । इस नियम का अनुप्रयोग करके किसी एकसमान आवेशित अनन्त समतल चादर के निकट किसी बिन्दु पर विद्युत क्षेत्र $\vec{E}$ प्राप्त कीजिए ।

(ii) दो लम्बे सीधे तार 1 और 2 आरेख में दर्शाए अनुसार रखे गए हैं । इन दोनों तारों के रैखिक आवेश घनत्व क्रमश: $\lambda_1 = 10\ \mu C/m$ और $\lambda_2 = -20\ \mu C/m$ हैं । बिन्दु P पर स्थित किसी इलेक्ट्रॉन द्वारा अनुभव किया जाने वाला नेट बल $\vec{F}$ ज्ञात कीजिए । *5*



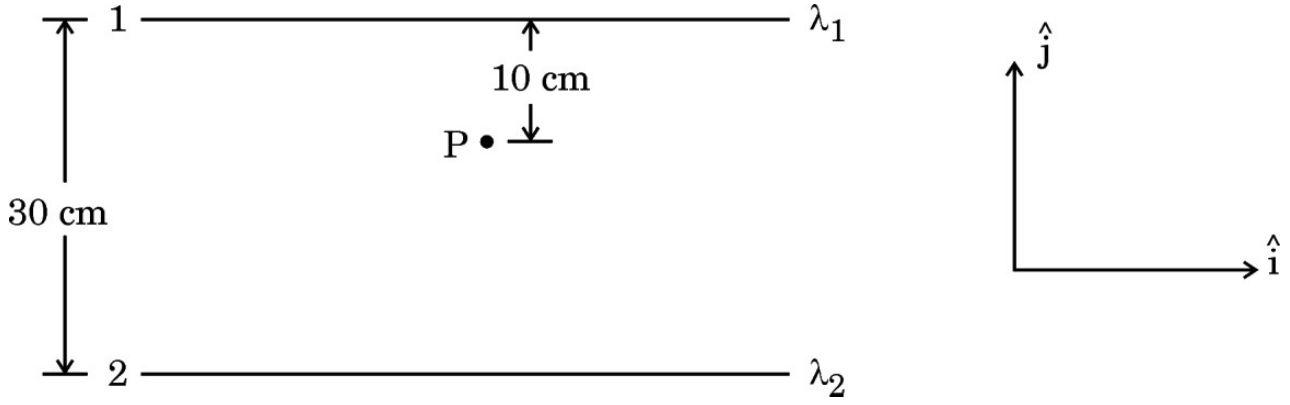
32. (a) (i) Obtain an expression for the electric potential due to a small dipole of dipole moment $\vec{p}$, at a point $\vec{r}$ from its centre, for much larger distances compared to the size of the dipole.

(ii) Three point charges q, 2q and nq are placed at the vertices of an equilateral triangle. If the potential energy of the system is zero, find the value of n. *5*

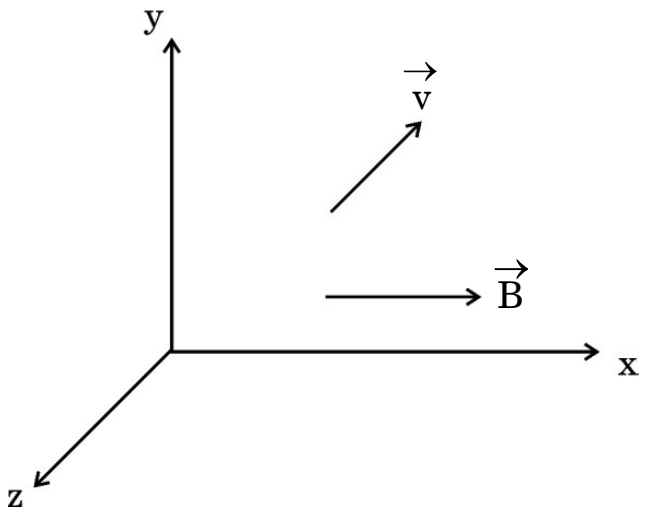
OR

(b) (i) State Gauss's Law in electrostatics. Apply this to obtain the electric field $\vec{E}$ at a point near a uniformly charged infinite plane sheet.

(ii) Two long straight wires 1 and 2 are kept as shown in the figure. The linear charge density of the two wires are $\lambda_1 = 10\ \mu C/m$ and $\lambda_2 = -20\ \mu C/m$. Find the net force $\vec{F}$ experienced by an electron held at point P. *5*



33. (क) (i) आरेख में दर्शाए अनुसार द्रव्यमान m और आवेश q का कोई कण किसी चुम्बकीय क्षेत्र $\vec{B}$ में वेग $\vec{v}$ से गतिमान है । यह दर्शाइए कि यह कण कुण्डलिनी पथ पर गमन करता है । इस प्रकार इसके परिक्रमण की आवृत्ति प्राप्त कीजिए ।



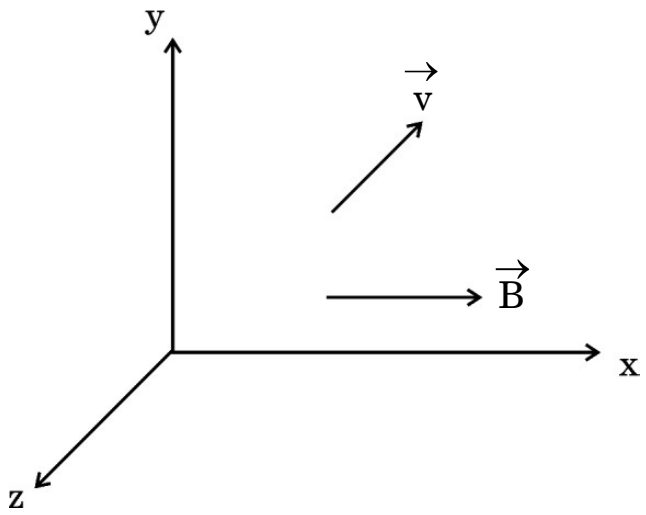
(ii) किसी हाइड्रोजन परमाणु में कोई इलेक्ट्रॉन 2 Å त्रिज्या की किसी कक्षा में 8×10^{14} परिक्रमण प्रति सेकण्ड से गति कर रहा है । इस इलेक्ट्रॉन की कक्षीय गति से संबद्ध चुम्बकीय आघूर्ण ज्ञात कीजिए । *5*

अथवा

(ख) (i) किसी गैल्वेनोमीटर की धारा सुग्राहिता किसे कहते हैं ? दर्शाइए कि किसी गैल्वेनोमीटर की धारा सुग्राहिता में वृद्धि किस प्रकार की जा सकती है । "किसी गैल्वेनोमीटर की धारा सुग्राहिता में वृद्धि होने पर यह आवश्यक नहीं है कि उसकी वोल्टता सुग्राहिता में भी वृद्धि हो ।" व्याख्या कीजिए ।

(ii) किसी चल कुण्डली गैल्वेनोमीटर का प्रतिरोध 15 Ω है तथा वह पूर्ण पैमाना विक्षेपण के लिए 20 mA धारा लेता है । इस गैल्वेनोमीटर को (0 – 100 V) परिसर के वोल्टमीटर में किस प्रकार परिवर्तित किया जा सकता है ? *5*

33. (a) (i) A particle of mass m and charge q is moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}$ as shown in the figure. Show that it follows a helical path. Hence, obtain its frequency of revolution.



(ii) In a hydrogen atom, the electron moves in an orbit of radius 2 Å making 8×10^{14} revolutions per second. Find the magnetic moment associated with the orbital motion of the electron. *5*

OR

(b) (i) What is current sensitivity of a galvanometer ? Show how the current sensitivity of a galvanometer may be increased. "Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity." Explain.

(ii) A moving coil galvanometer has a resistance 15 Ω and takes 20 mA to produce full scale deflection. How can this galvanometer be converted into a voltmeter of range 0 to 100 V ? *5*

Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT- PHYSICS (CODE 55/2/1)

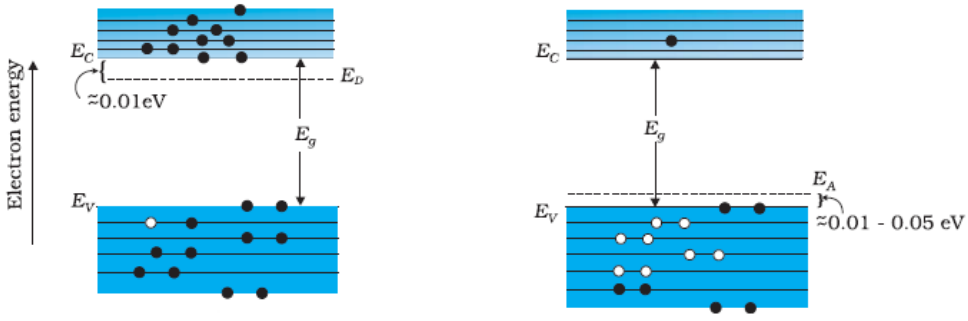
General Instructions: -

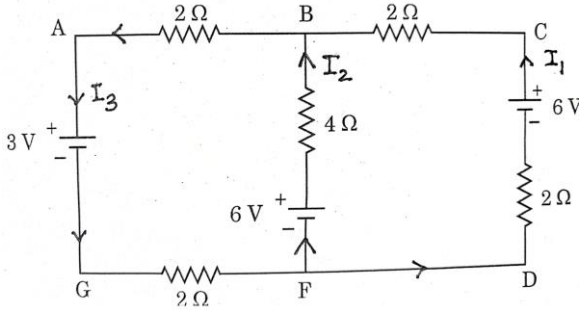
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested 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 0 – 70 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 :55/2/1			
Q.No	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION –A		
1.	(C) $\sqrt{\frac{m_p}{m_Q}}$	1	1
2.	(A) $\frac{v_d}{2}$	1	1
3.	(B) $1.54 Am^2$	1	1
4.	(C) 31.4μWb	1	1
5.	(D) Magnetic Flux and Power both	1	1
6.	(B) 100V	1	1
7.	(B) Ultraviolet rays	1	1
8.	(C) 375 nm	1	1
9.	(B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$	1	1
10.	(C) $\frac{1}{K}$	1	1
11.	(C) P	1	1
12.	(B) The barrier height increases and the depletion region widens.	1	1
13.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	1	1
14.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	1	1
15.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	1	1
16.	(C) Assertion(A) is true, but Reason (R) is false	1	1
	SECTION -B		
17.	Defining resistivity 1 Dependence of resistivity on (a) Number density of free electron ½ (b) Relaxation time ½ Resistance offered by a material of unit length and having unit cross-sectional area is called resistivity. **1** $\rho=\frac{m}{ne^2\tau}$ (a) $\rho \alpha \frac{1}{n}$ ½ (b) $\rho \alpha \frac{1}{\tau}$ ½		**2**

18.	**(a)** Obtaining expression for resultant intensity 2 $x_1 = a\cos\omega t$ $x_2 = a\cos(\omega t + \phi)$ $x = x_1 + x_2$ $= a(\cos\omega t + \cos(\omega t + \phi))$ $= a(2\cos(\omega t + \frac{\phi}{2})\cos\frac{\phi}{2})$ $= 2a\cos\frac{\phi}{2}\cos(\omega t + \frac{\phi}{2})$ Intensity $I = K\,(\text{amplitude})^2$ where K is a constant. $= K(2a\cos\frac{\phi}{2})^2$ $= 4I_0\cos^2\frac{\phi}{2}$ $I_o = Ka^2$ = intensity of each incident wave. **(Note : Award full credit of this part for all other alternative correct methods)** **OR** **(b)** Effect and justification (i) Source slit moved closer to plane of slits 1 (ii) Separation between two slits 1 (i)Sharpness of interference pattern decreases $\frac{s}{S} < \frac{\lambda}{d}$ As S decreases, interference patterns produced by different parts of the source overlap and finally fringes disappear. **Alternatively** As the source slit is brought closer to the plane of the slits, the screen gets illuminated uniformly and fringes disappear. **Alternatively** Interference pattern is not formed. **(Note : Award full credit of this part if a student merely attempts this part.)** (ii) $\beta = \frac{\lambda D}{d}$ As d increases, β decreases and fringes disappear.	½ ½ ½ **1** ½ ½	**2**
19.	Finding focal length 1 ½ Nature of the lens ½ For convex lens in air $\frac{1}{f_a} = \left(\frac{n_g}{n_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$		

	For convex lens in liquid. $\frac{1}{f_l} = \left(\frac{n_g}{n_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\frac{f_l}{f_a} = \frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$ $= -6.6$ $f_l = -6.6\ f_a$ $= -99\text{cm}$ Nature of the lens: Diverging/ behaves like a concave lens.	½ ½ ½ ½	**2**
20.	Calculation of binding energy 2 Binding Energy $= (Zm_p + (A-Z)m_n - M_N) \times 931.5$ MeV B. E. $= (6 \times 1.007825 + 6 \times 1.008665 - 12.000000)$ x 931.5 MeV $= (0.09894)$ x 931.5 MeV B. E. = 92.16 MeV	½ ½ ½ ½	**2**
21.	Effect on energy gap and justification (i) Trivalent impurity ½ + ½ (ii) Pentavalent impurity ½ + ½ (i) Decreases Justification: An acceptor energy level is formed just above the top of the valence band. (ii) Decreases Justification: A donor level is formed just below the bottom of conduction band. **Alternatively**  **(Note : Award the credit of justification if a student draws band diagram)**	½ ½ ½ ½	**2**
	SECTION C		
22.	Finding magnitude and direction of current in AG, BF and CD 1+1+1		



By Kirchoff's Laws (at point B)

$I_1 + I_2 = I_3$ .....(1) ½

In the closed loop AGFBA

$3 + 2I_3 - 6 + 4I_2 + 2I_3 = 0$ ½

$I_2 + I_3 = \frac{3}{4}$ .....(2)

From (i) ½

$2I_1 + I_2 = \frac{3}{4}$ .....(3)

In closed loop BFDCB ½

$-4I_2 + 6 + 2I_1 - 6 + 2I_1 = 0$

$I_2 - I_1 = 0$

$I_2 = I_1$ .....(4)

Putting in (3) ½

$I_1 = \frac{1}{4} A$

From (4)

$I_2 = \frac{1}{4} A$

From (2) $I_3 = \frac{1}{2} A$ ½ **3**

23.

(a) Factors affecting speed of Electromagnetic wave	1
(b) Production of Electromagnetic wave	1
(c) Sketch of Electromagnetic wave	1

(a) Speed of EM waves $v = \frac{1}{\sqrt{\mu\varepsilon}}$

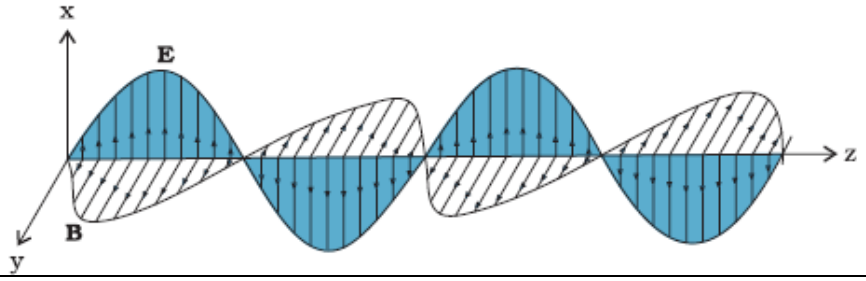
Speed depends upon

(i) Permittivity (ε) of medium ½ + ½

(ii) Magnetic permeability (μ) of medium

(b) Accelerated charges or oscillating charges produce electromagnetic waves **1**

(c)



1 **3**

24.

Calculation of current induced in the coil	3

Induced emf $(\varepsilon) = \dfrac{-Nd\phi}{dt}$ ½

$= \dfrac{-NAdB}{dt}$

$= -NA\dfrac{d}{dt}(\mu_0 nI)$

$= -N\mu_0 n(\pi r^2)\dfrac{dI}{dt}$

$\varepsilon = \dfrac{100\times 4\pi\times 10^{-7}\times 250\times 10^2\times\pi\times(1.6\times 10^{-2})^2\times 1.5}{25\times 10^{-3}}$ **1**

$=0.1536\text{V}$ ½

$I = \dfrac{\varepsilon}{R}$ ½

$= 0.03\text{A}$ ½

Alternatively

$\varepsilon = -M\dfrac{dI}{dt}$ ½

$M = \mu_0 n_1 n_2 \pi r_1^2 l$ ½

$= \mu_0 (n_1 l) n_2 \pi r_1^2$

$= 4\pi\times 10^{-7}\times 100\times 250\times 10^2\times\pi\times(1.6\times 10^{-2})^2$

$= 2.56\times 10^{-3} H$ ½

$= -2.56\times 10^{-3}\times\dfrac{(0-1.5)}{25\times 10^{-3}}$

$=0.1536\text{V}$ ½

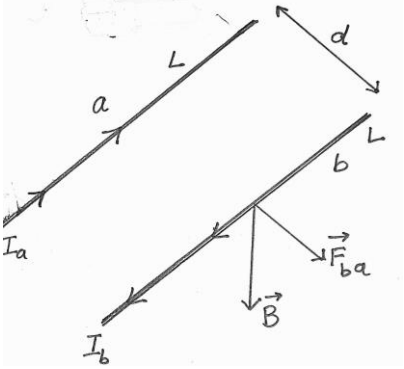
$I = \dfrac{\varepsilon}{R} = \dfrac{0.1536}{5}$ ½

$= 0.03\text{A}$ ½ **3**

25. **(a)**

Explaining nature of force	½
Obtaining expression of force	1½
Defining one ampere	1

Nature of force is repulsive. ½



½

Magnetic field due to current I_a at all points of conductor b

$B_{ab} = \frac{\mu_0 I_a}{2\pi d}$ directed downwards

½

Force experienced by conductor b on its segment of length *l*

$F_{ab} = I_b l B_{ab}$

$= \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left

½

Similarly

Force experienced by conductor a on its segment of length *l*

$F_{ba} = \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right

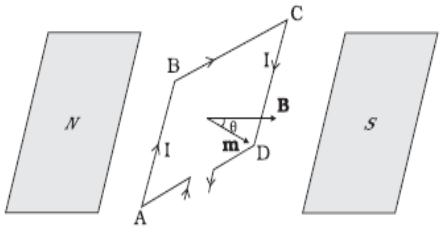
One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2×10^{-7} N/m on each conductor.

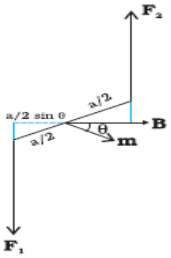
1

OR

(b)

Obtaining expression of torque	2
Drawing diagram	1





1

Forces on arm BC and DA are equal and opposite and act along the axis of the coil. Being collinear they cancel each other.

½

Forces on arms AB and CD are equal and opposite but not collinear. They form a couple.

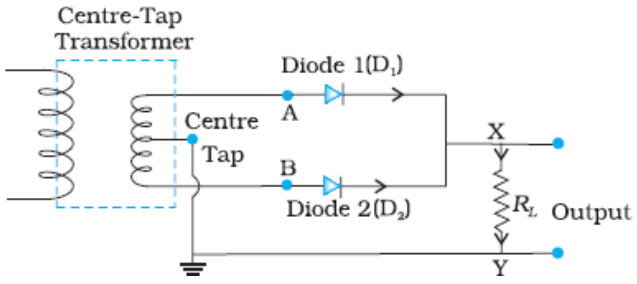
$F_1 = F_2 = IbB$

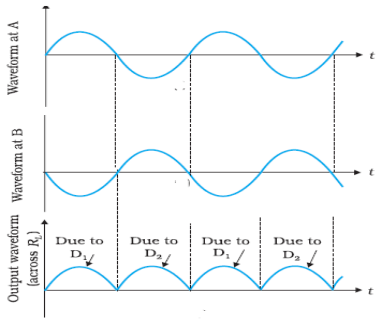
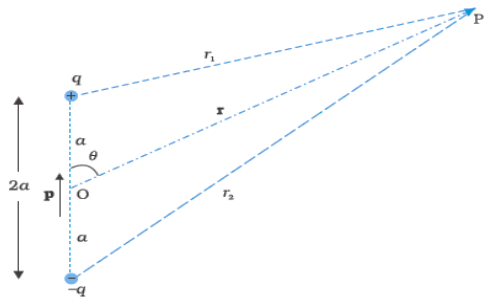
½

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

$\tau = IabB \sin\theta$

½

	$\tau = IAB\sin\theta$ (where A = ab & m = IA) $\vec{\tau} = \vec{m} \times \vec{B}$	½	**3**
26.	Deriving expression for radius 2 Finding numerical value of a_o 1 From Bohr's second postulate $mvr = \frac{nh}{2\pi}$ ……(1) Also $\frac{mv^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2}$ (z=1) $v = \frac{e}{\sqrt{4\pi\varepsilon_0 mr}}$ Substituting in (1) and simplifying $r = \frac{n^2h^2\varepsilon_0}{\pi me^2}$ For n = 1 r = a_o (Bohr's radius) $a_o = \frac{(6.63\times10^{-34})^2 \times 8.854\times10^{-12}}{3.14\times9.1\times10^{-31}\times(1.6\times10^{-19})^2}$ = $5.29\text{x}10^{-11}$m = 0.53Å	½ ½ ½ ½ ½ ½	**3**
27.	(a) Interpretation of slope of line and justification ½ + ½ (b) Identification and justification ½ + ½ (c) Validation of graph and justification ½ + ½ (a) $\lambda = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2m}} \times \frac{1}{\sqrt{K}}$ $slope = \frac{h}{\sqrt{2m}}$ (b) $slope\,\alpha\,\frac{1}{\sqrt{m}}$ Slope of m_2 is more than that of m_1.Therefore, m_1 is heavier. (c) No Momentum (p) = $\sqrt{2mK}$ is not valid for a photon	½ ½ ½ ½ ½ ½	**3**
28.	Explaining working of full wave rectifier 2 Drawing input and output wave forms 1  When input voltage at 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,	**1** ½	

	during the positive half cycle diode D_1 gets forward biased and conducts while diode D_2 gets reverse biased and does not conduct. Hence during positive 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. We get output voltage in both positive and negative half cycles.  	½ 1	3
29.	(i) (B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte. (ii) (B) 2.8 V (iii) (A) $\varepsilon = V_+ + V_- > 0$ (iv) (a) (D) 0.2A **OR** (b) (A) 1.0Ω	1 1 1 1	4
30.	(i) Since no option is correct, award 1 mark to all students. (ii) (D) 800 nm (iii) (a) (A) $\frac{\sqrt{3}}{2}$ **OR** (b) (B) $\sin^{-1}\left(\frac{4}{5}\right)$ (iv) (A) $\sin^{-1}\sqrt{n^2-1}$	1 1 1 1	4
31.	**(a)** (i) Obtaining expression for electric potential 3 (ii) Finding the value of n 2 (i)  Potential due to the dipole is the sum of potentials due to charges q and -q	 ½ ½	

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right)$$ ----------(1)

By geometry

$r_1^2 = r^2 + a^2 - 2ar\cos\theta$ ½

$r_2^2 = r^2 + a^2 + 2ar\cos\theta$

For r >> a, retaining terms only up to first order in a/r

$$r_1^2 = r^2\left(1 - \frac{2a\cos\theta}{r} + \frac{a^2}{r^2}\right)$$

$$\cong r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$

Similarly ½

$$r_2^2 \cong r^2\left(1 + \frac{2a\cos\theta}{r}\right)$$

Using the binomial theorem and retaining terms up to the first order in a/r

$$\frac{1}{r_1} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-1/2}$$

$$\cong \frac{1}{r}\left(1 + \frac{a\cos\theta}{r}\right)$$ ----------(2)

$$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1 + 2a\cos\theta}{r}\right)^{-1/2}$$ ----------(3) ½

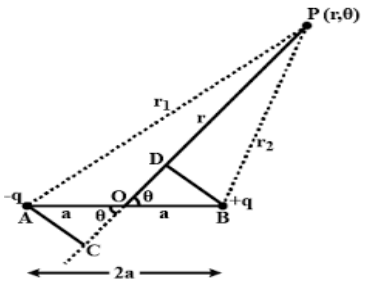
$$\cong \frac{1}{r}\left(1 - \frac{a\cos\theta}{r}\right)$$

Using eqn. (1) (2), (3) and p = 2qa

$$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$$ ½

$$= \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$

Alternatively –



½

$r_2 = r + a\cos\theta$ ½

$r_1 = r - a\cos\theta$

$$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$ ½

$$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r - a\cos\theta} - \frac{1}{r + a\cos\theta}\right)$$

$$= \frac{q}{4\pi\varepsilon_0}\left(\frac{2a\cos\theta}{r^2 - a^2\cos^2\theta}\right)$$ ½

½

$$= \frac{p}{4\pi\varepsilon_0 r^2}\left(\frac{\cos\theta}{1-\frac{a^2}{r^2}\cos^2\theta}\right)$$ ½

For r>>a, neglecting $\frac{a^2}{r^2}$

V= $\frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$ ½

(ii) Consider the side of equilateral triangle as 'a'

Potential energy = U= $\frac{kq_1q_2}{a}+\frac{kq_2q_3}{a}+\frac{kq_1q_3}{a}$ ½

According to question

$U = \frac{k(q)(2q)}{a}+\frac{k(2q)(nq)}{a}+\frac{k(q)(\text{n}\,q)}{a}=0$ ½

$= \frac{2q^2}{a}+\frac{2nq^2}{a}+\frac{\text{n}\,q^2}{a}=0$

$2+2n+n=0$ ½

$3n=-2$

$n=-\frac{2}{3}$

OR

(b)

(i) Statement of Gauss's Law	1
Obtaining expression for electric field	2
(ii) Finding net force on electron	2

1

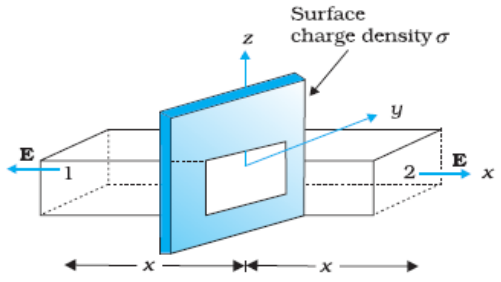
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi = \frac{q}{\varepsilon_0}$

Alternatively

The surface integral of electric field over a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

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

(Award ½ mark for writing the formula only.)

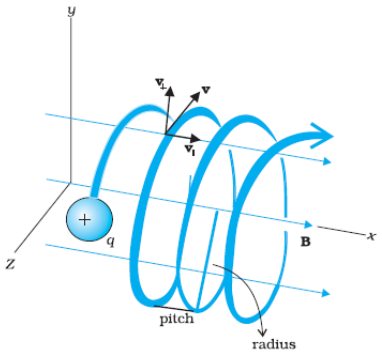


½

(Gaussian surface can be cylindrical also)

As seen from figure, only two faces 1 and 2 will contribute to the flux.

Flux $\vec{E}.d\vec{s}$ through both the surfaces is equal and add up. ½

	The charge enclosed by surface is σA, where σ is surface charge density According to Gauss's theorem $2EA = \sigma A / \varepsilon_0$ $E = \sigma / 2\varepsilon_0$ $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ where n̂ is unit vector directed normally out of the plane (ii) $\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$ According to question E_1 (at point P) $= \frac{\lambda_1}{2\pi\varepsilon_0 r_1}$ $\vec{E} = \frac{10\times10^{-6}}{2\pi\varepsilon_0(10\times10^{-2})}(-\hat{j})\ N/C$ E_2 (at point P) $= \frac{\lambda_2}{2\pi\varepsilon_0 r_2}$ $\vec{E} = \frac{20\times10^{-6}}{2\pi\varepsilon_0(20\times10^{-2})}(-\hat{j})\ N/C$ $E_{net} = \frac{10\times10^{-6}}{2\pi\varepsilon_0}\left(\frac{1}{0.1}+\frac{2}{0.2}\right)(-\hat{j})\ N/C$ $= 3.6\times10^{6}\ (-\hat{j})\ N/C$ $\vec{F}_{net} = q\times\vec{E}_{net}$ $\vec{F} = -1.6\times10^{-19}\times3.6\times10^{6}(-\hat{j})\ N$ $= 5.76\times10^{-13}N\ (\hat{j})$	½ ½ ½ ½ ½ ½	5
32.	**(a)** (i) Showing helical path 1 ½ Obtaining frequency of revolution 1 ½ (ii) Finding magnetic moment of electron 2  $v_\perp = v\sin\theta$ is perpendicular to $\vec{B}$ and $v_\parallel = v\cos\theta$ is parallel to $\vec{B}$ Due to $v_\perp$ the charge describes circular path and $v_\parallel$ pushes it in the direction of $\vec{B}$. Therefore under the combined effect of two components the charged particle describes helical path, as shown in the figure. The centripetal force	½ 1	

$\frac{mv_\perp^2}{r} = B\,qv_\perp$ ½

$v_\perp = \frac{Bqr}{m}$ $(v_\perp = v\sin\theta)$ ½

Time period = $T = \frac{2\pi r}{v_\perp}$

$= \frac{2\pi m}{Bq}$

$frequency\, v = \frac{1}{T} = \frac{Bq}{2\pi m}$ ½

(ii) Magnetic moment $m = I\,A$

$I = \frac{e}{T} = ev$ ½

$= 1.6\times10^{-19}\times8\times10^{14}$

$= 1.28\times10^{-4}\,A$ ½

$M = 1.28\times10^{-4}\times3.14\times(2\times10^{-10})^2$ ½

$= 5.12\pi\times10^{-24}\,Am^2 = 1.6\times10^{-23}\,Am^2$ ½

OR

(b)

(i) Definition of current sensitivity	1
Showing dependence of current sensitivity & explanation	1+1
(ii) Calculation of resistance	2

(i) Deflection produced per unit current is called its current sensitivity. **1**

$I_S = \frac{\theta}{I} = \frac{NBA}{K}$

Current sensitivity can be increased by
(a) increasing number of turns in coil
(b) increasing area of coil in magnetic field **1**
(c) decreasing K (Torsional Constant)
(any one)

$V_s = \frac{\theta}{V} = \frac{NBA}{KR}$

If current sensitivity is increased by increasing number of turns of the coil, the resistance of the galvanometer will also increase. Thus voltage sensitivity may not increase. **1**

(ii) $V = I_G(R+G)$

$R = \frac{V}{I_G} - G$ ½

$= \frac{100}{20\times10^{-3}} - 15$ ½

$= 5000 - 15$

$= 4985\Omega$ ½

By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V) ½ **5**

33. **(a)**

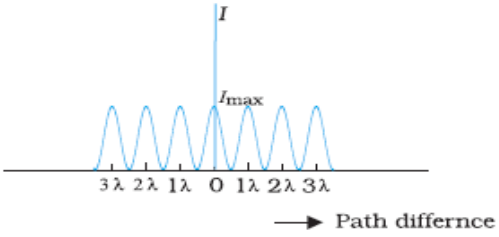
(i) Two differences between interference pattern and diffraction pattern	2
(ii) Intensity distribution graph	1
(iii) Finding intensity of light	2

(i)

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands is same.	Intensity of maxima decreases on either side of central maxima.
3	First maxima is at an angle λ / a	First minima is at an angle λ / a

1 + 1

(ii)



1

(iii) Path difference $(\Delta) = \lambda$

$$\phi = \frac{2\pi\Delta}{\lambda}$$

$$\phi = 2\pi$$ ½

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

$$K = 4I_0 \cos^2 \pi \ = 4I_0$$ ½

$$\text{Path difference} = \frac{\lambda}{6}$$

$$\phi = \pi / 3$$ ½

$$I = 4I_0 \cos^2 \frac{\pi}{6}$$

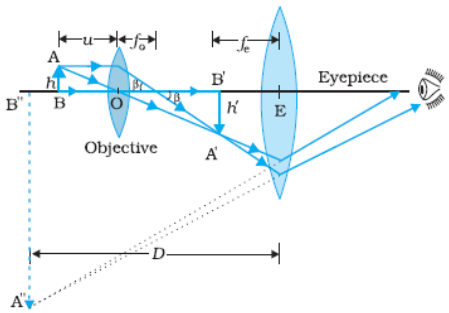
$$= 4I_0 \times \frac{3}{4}$$

$$= \frac{3}{4}\text{K}$$ ½

OR

(b)

(i) Drawing labeled ray diagram	1
Derivation of magnifying power	2
(iii) Finding magnifying power	2

	(i)  The magnification obtained by eye-piece lens $m_e = \left(1+\frac{D}{f_e}\right)$ The magnification obtained by objective lens $m_0 = \frac{v_0}{-u_0}$ Hence the total magnifying power is $m = m_0 \times m_e$ $= \frac{v_0}{-u_0}\left(1+\frac{D}{f_e}\right)$ $(ii)\,\mathrm{m} = \left\|\frac{f_0}{f_e}\right\|$ Identification of focal length of objective and eyepiece $f_0 = 100cm$ $f_e = 5cm$ $m = \left\|\frac{100}{5}\right\| = 20$	**1** ½ ½ ½ ½ **1** ½ ½	**5**

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

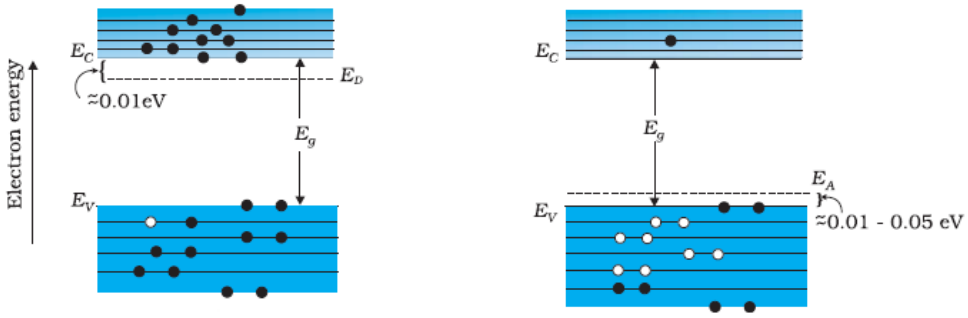
General Instructions: -

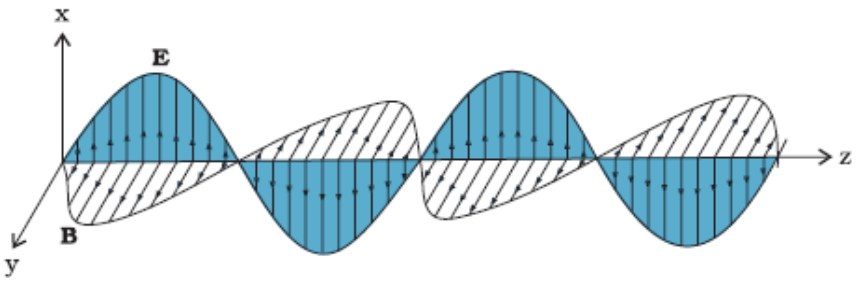
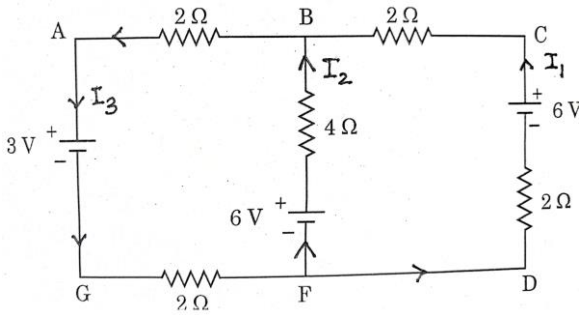
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested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

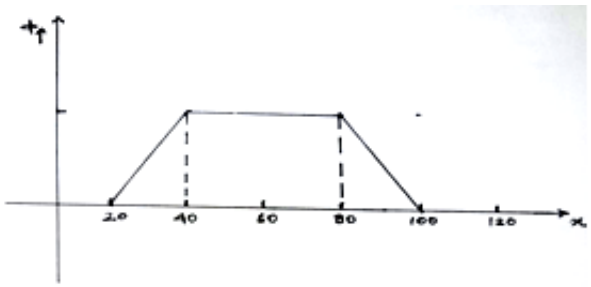
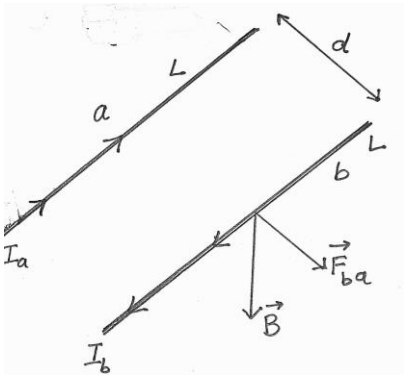
	retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 – 70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every 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.

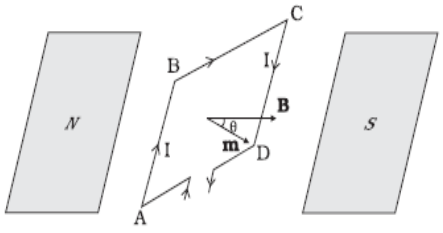
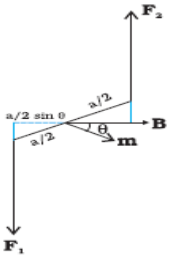
MARKING SCHEME : PHYSICS (042)			
CODE : 55/2/2			
Q.No	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
SECTION -A			
1.	(C) $\frac{C}{4}$	**1**	**1**
2.	(A) $\frac{v_d}{2}$	**1**	**1**
3.	(D) $\varepsilon_1 > \varepsilon_3 > \varepsilon_2$	**1**	**1**
4.	(C) 31.4μWb	**1**	**1**
5.	(D) Magnetic Flux and Power both	**1**	**1**
6.	(A) $\frac{10^5}{4\pi}$ Hz	**1**	**1**
7.	(B) Ultraviolet rays	**1**	**1**
8.	(D) 2.14 e V	**1**	**1**
9.	(B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$	**1**	**1**
10.	(C) $\frac{1}{K}$	**1**	**1**
11.	(C) P	**1**	**1**
12.	(B) The barrier height increases and the depletion region widens.	**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 the correct explanation of the Assertion (A)	**1**	**1**
15.	(B) Both Assertion (A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	**1**	**1**
16.	(A) Both Assertion (A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
SECTION – B			
17	(a) Explanation 1 (b) Explanation 1 (a) Electric field is established throughout the circuit, almost instantly. It causes a local electron drift at every point, thus establishment of current does not have to wait for electrons from one end of the conductor to travel to other end. (b) Ohm's law asserts that the plot of I versus V is linear i.e. R is independent of V, while equation V=IR defines resistance and it may be applied to all conducting devices whether they obey Ohm's law or not.	**1** **1**	**2**
18	Finding focal length 1 ½ Nature of the lens ½		

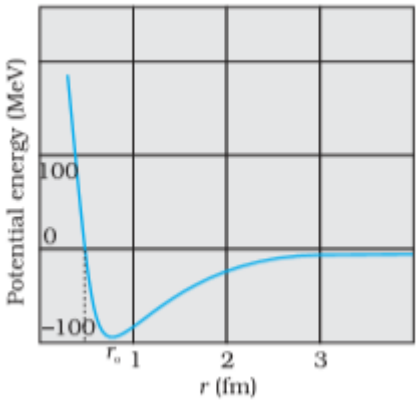
	For convex lens in air $\frac{1}{f_a}=\left(\frac{n_g}{n_a}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ For convex lens in liquid. $\frac{1}{f_l}=\left(\frac{n_g}{n_l}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ $\frac{f_l}{f_a}=\frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$ $= -6.6$ $f_l = -6.6\ f_a$ $= -99$cm Nature of the lens: Diverging/ behaves like a concave lens.	½ ½ ½ ½	**2**
19.	**(a)** Obtaining expression for resultant intensity 2 $x_1 = a\cos\omega t$ $x_2 = a\cos(\omega t+\phi)$ $x = x_1 + x_2$ $= a(\cos\omega t + \cos(\omega t+\phi))$ $= a(2\cos(\omega t+\frac{\phi}{2})\cos\frac{\phi}{2})$ $= 2a\cos\frac{\phi}{2}\cos(\omega t+\frac{\phi}{2})$ Intensity I = K (amplitude)^2 where K is a constant. $= K(2a\cos\frac{\phi}{2})^2$ $= 4I_0\cos^2\frac{\phi}{2}$ $I_o = Ka^2$ = intensity of each incident wave. **(Award full credit of this part for all other alternative correct methods)** **OR** **(b)** Effect and justification (i) Source slit moved closer to plane of slits 1 (ii) Separation between two slits 1 (i)Sharpness of interference pattern decreases $\frac{s}{S}<\frac{\lambda}{d}$ As S decreases, interference patterns produced by different parts of the source overlap and finally fringes disappear. **Alternatively** As the source slit is brought closer to the plane of the slits, the screen gets illuminated uniformly and fringes disappear.	½ ½ ½ ½ **1**	

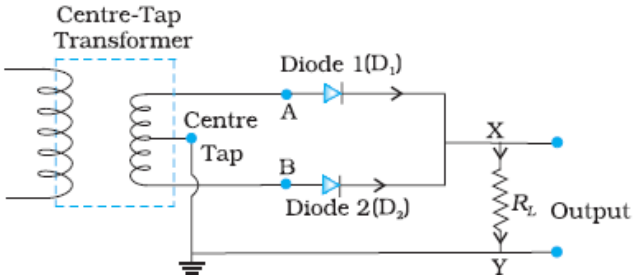
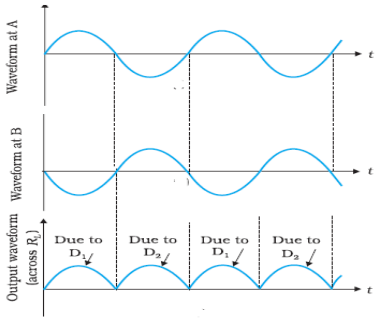
	Alternatively Interference pattern is not formed. **(Note : Award full credit of this part if a student merely attempts this part.)** (ii) $\beta = \frac{\lambda D}{d}$ As d increases, β decreases and fringes disappear.	½ ½	**2**
20.	Calculating energy released/ absorbed 2 Energy = mass defect x 931 Mev Mass defect $= \Delta m = (2 \times 12.000000 - 19.992439 - 4.002603)$ $= 0.004958$u Energy released = 0.004958 x 931 MeV = 4.62 MeV	½ ½ ½ ½	**2**
21.	Effect on energy gap and justification (i) Trivalent impurity ½ + ½ (ii) Pentavalent impurity ½ + ½ (i) Decreases Justification: An acceptor energy level is formed just above the top of the valence band. (ii) Decreases Justification: A donor level is formed just below the bottom of conduction band. **Alternatively**  **(Note : Award the credit of justification if a student draws band diagram)**	½ ½ ½ ½	**2**
	SECTION-C		
22.	(a) Factors affecting speed of Electromagnetic wave 1 (b) Production of Electromagnetic wave 1 (c) Sketch of Electromagnetic wave 1 (a) Speed of EM waves $v = \frac{1}{\sqrt{\mu\varepsilon}}$ Speed depends upon		

	(i) Permittivity (ε) of medium (ii) Magnetic permeability (μ) of medium (b) Accelerated charges or oscillating charges produce electromagnetic waves (c) 	½ + ½ **1** **1**	**3**
23.	Finding magnitude and direction of current in AG, BF and CD 1+1+1  By Kirchoff's Laws (at point B) $I_1 + I_2 = I_3$ .....(1) In the closed loop AGFBA $3+ 2I_3 – 6 + 4I_2 + 2I_3 = 0$ $I_2 + I_3 = \frac{3}{4}$ .....(2) From (i) $2I_1 + I_2 = \frac{3}{4}$ .....(3) In closed loop BFDCB $- 4I_2 + 6 + 2I_1 - 6 + 2I_1=0$ $I_2 - I_1 = 0$ $I_2 = I_1$ .....(4) Putting in (3) $I_1 = \frac{1}{4} A$ From (4) $I_2 = \frac{1}{4} A$ From (2) $I_3 = \frac{1}{2} A$	½ ½ ½ ½ ½	**3**

24.	(a) Plotting graph 1½ (b) Finding magnetic flux 1 (c) Requirement of external work ½ (a)  (b) $\phi = B.A$ $= 5\times10^{-3}\times20\times10^{-2}\times10\times10^{-2}$ $= 10^{-4} Wb$ (c) Yes, external work is required.	**1 ½** ½ ½ ½	**3**
25.	**(a)** Explaining nature of force ½ Obtaining expression of force 1½ Defining one ampere 1 Nature of force is repulsive.  Magnetic field due to current I_a at all points of conductor b $B_{ab} = \frac{\mu_0 I_a}{2\pi d}$ directed downwards Force experienced by conductor b on its segment of length l $F_{ab} = I_b l B_{ab}$ $= \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left Similarly Force experienced by conductor a on its segment of length l	½ ½ ½	

	$F_{ba} = \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2×10^{-7} N/m on each conductor. **OR** **(b)** Obtaining expression of torque 2 Drawing diagram 1   Forces on arm BC and DA are equal and opposite and act along the axis of the coil. Being collinear they cancel each other. Forces on arms AB and CD are equal and opposite but not collinear. They form a couple. $F_1 = F_2 = IbB$ $\tau = F_1 \frac{a}{2} \sin\theta + F_2 \frac{a}{2} \sin\theta$ $\tau = IabB \sin\theta$ $\tau = IAB \sin\theta$ (where A = ab & m = IA) $\vec{\tau} = \vec{m} \times \vec{B}$	1 1 ½ ½ ½ ½	3
26.	(a) Explaining de Broglie hypothesis 1 (b) Finding ratio of de Broglie wavelength i) Accelerated through same potential difference 1 ii) Moving with same kinetic energy 1 (a) Moving particles of matter display wave like properties under suitable conditions. The wave length λ associated with a particle of momentum p is given as $\lambda = \frac{h}{p} = \frac{h}{mv}$ λ is the attribute of a wave while momentum is a typical attribute of particle. (b) (i) $\lambda = \frac{h}{\sqrt{2meV}}$ $\frac{\lambda_p}{\lambda_\alpha} = \frac{\sqrt{2 \times 4m_p \times 2e \times V}}{\sqrt{2 \times m_p \times e \times V}}$	1 ½	

	$= 2\sqrt{2}$ (ii) $\lambda = \frac{h}{\sqrt{2mK}}$ $\frac{\lambda_p}{\lambda_\alpha} = \frac{\sqrt{2 \times 4m_p \times K}}{\sqrt{2 \times m_p \times K}}$ $= 2$	½ ½ ½	**3**
27.	(a) Plotting graph 1 (b) Identifying and justifying regions i) Attracting nuclear force ½ + ½ ii) Repulsive nuclear force ½ + ½ (a)  (**Give full credit for graph without values)** (b) $F = -\frac{dU}{dx}$ i) For distance larger than r_o, force is attractive Since slope of the curve is positive ii) For distance less than r_o, force is repulsive Since slope of the curve is negative	**1** ½ ½ ½ ½	**3**
28.	Explaining working of full wave rectifier 2 Drawing input and output wave forms 1		

	 When input voltage at 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, during the positive half cycle diode D_1 gets forward biased and conducts while diode D_2 gets reverse biased and does not conduct. Hence during positive 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. We get output voltage in both positive and negative half cycles. 	1 ½ ½ 1	3
29	(i) Since no option is correct, award 1 mark to all students. (ii) (D) 800 nm (iii) (a) (A) $\frac{\sqrt{3}}{2}$ **OR** (b) (B) $\sin^{-1}\left(\frac{4}{5}\right)$ (iv) (A) $\sin^{-1}\sqrt{n^2-1}$	1 1 1 1	4
30	(i) (B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte. (ii) (B) 2.8 V (iii) (A) $\varepsilon = V_+ + V_- > 0$ (iv) (a) (D) 0.2A **OR** (b) (A) 1.0Ω	1 1 1 1	4

31.

(a)

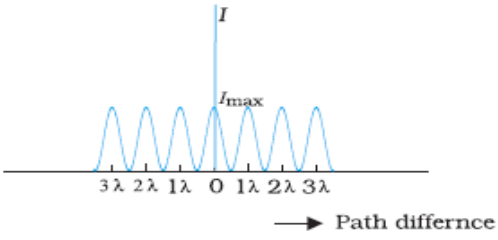
(i) Two differences between interference pattern and diffraction pattern	2
(ii) Intensity distribution graph	1
(iii) Finding intensity of light	2

(i)

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands are same.	Intensity of maxima decreases on either side of central maxima.
3	First maxima is at an angle λ / a	First minima is at an angle λ / a

1 + 1

(ii)



1

(iii) Path difference $(\Delta) = \lambda$

$$\phi = \frac{2\pi\Delta}{\lambda}$$

½

$$\phi = 2\pi$$

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

$$K = 4I_0 \cos^2 \pi \ = 4I_0$$

½

$$\text{Path difference} = \frac{\lambda}{6}$$

$$\phi = \pi / 3$$

$$I = 4I_0 \cos^2 \frac{\pi}{6}$$

½

$$= 4I_0 \times \frac{3}{4}$$

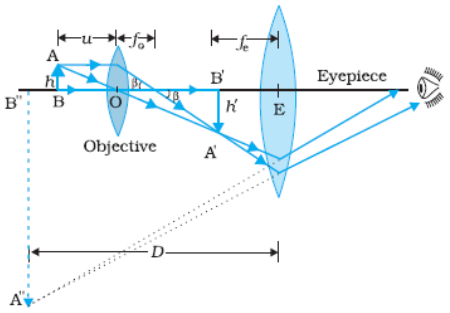
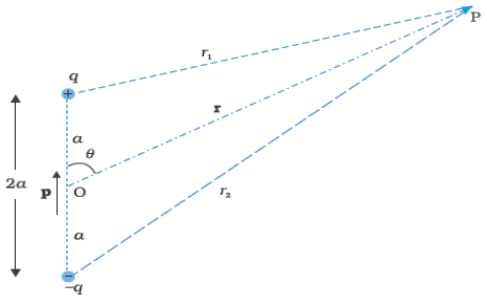
$$= \frac{3}{4}\text{K}$$

½

OR

(b)

(i) Drawing labeled ray diagram	1
Derivation of magnifying power	2
(iii) Finding magnifying power	2

	(i)  The magnification obtained by eye-piece lens $m_e = \left(1+\frac{D}{f_e}\right)$ The magnification obtained by objective lens $m_0 = \frac{v_0}{-u_0}$ Hence the total magnifying power is $m = m_0 \times m_e$ $= \frac{v_0}{-u_0}\left(1+\frac{D}{f_e}\right)$ $(ii)\ \mathrm{m} = \left\|\frac{f_0}{f_e}\right\|$ Identification of focal length of objective and eyepiece $f_0 = 100cm$ $f_e = 5cm$ $m = \left\|\frac{100}{5}\right\| = 20$	**1** ½ ½ ½ **1** ½ ½	**5**
32.	**(a)** (i) Obtaining expression for electric potential 3 (ii) Finding the value of n 2 (i)  Potential due to the dipole is the sum of potentials due to charges q and -q $V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1}-\frac{q}{r_2}\right)$ ----------(1) By geometry $r_1^2 = r^2 + a^2 - 2ar\cos\theta$ $r_2^2 = r^2 + a^2 + 2ar\cos\theta$ For r >> a, retaining terms only up to first order in a/r	½ ½ ½	

$$r_1^2 = r^2\left(1-\frac{2a\cos\theta}{r}+\frac{a^2}{r^2}\right)$$

$$\cong r^2\left(1-\frac{2a\cos\theta}{r}\right)$$

Similarly

$$r_2^2 \cong r^2\left(1+\frac{2a\cos\theta}{r}\right)$$ ½

Using the binomial theorem and retaining terms up to the first order in a/r

$$\frac{1}{r_1} \cong \frac{1}{r}\left(1-\frac{2a\cos\theta}{r}\right)^{-1/2}$$

$$\cong \frac{1}{r}\left(1+\frac{a\cos\theta}{r}\right) \quad \text{----------(2)}$$

$$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1+2a\cos\theta}{r}\right)^{-1/2} \quad \text{----------(3)}$$

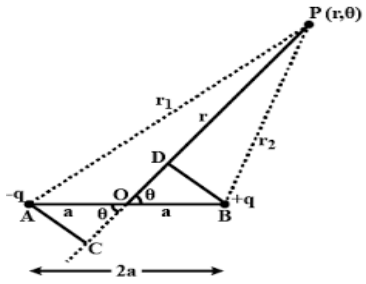
$$\cong \frac{1}{r}\left(1-\frac{a\cos\theta}{r}\right)$$ ½

Using eqn. (1) (2), (3) and p = 2qa

$$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$$

$$= \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$ ½

Alternatively –



½

$$r_2 = r + a\cos\theta$$

$$r_1 = r - a\cos\theta$$ ½

$$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$$

$$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r-a\cos\theta}-\frac{1}{r+a\cos\theta}\right)$$ ½

$$= \frac{q}{4\pi\varepsilon_0}\left(\frac{2a\cos\theta}{r^2-a^2\cos^2\theta}\right)$$ ½

$$= \frac{p}{4\pi\varepsilon_0 r^2}\left(\frac{\cos\theta}{1-\frac{a^2}{r^2}\cos^2\theta}\right)$$ ½

For r>>a, neglecting $\frac{a^2}{r^2}$

$$V = \frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$$ ½

(ii) Consider the side of equilateral triangle as ‘a’

Potential energy = U= $\frac{kq_1q_2}{a}+\frac{kq_2q_3}{a}+\frac{kq_1q_3}{a}$ ½

According to question

$U=\frac{k(q)(2q)}{a}+\frac{k(2q)(nq)}{a}+\frac{k(q)(n\,q)}{a}=0$ ½

$=\frac{2q^2}{a}+\frac{2nq^2}{a}+\frac{n\,q^2}{a}=0$ ½

$2+2n+n=0$

$3n=-2$

$n=-\frac{2}{3}$ ½

OR

(b)

(i) Statement of Gauss's Law	1
Obtaining expression for electric field	2
(ii) Finding net force on electron	2

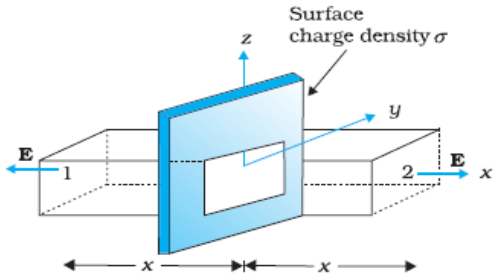
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi=\frac{q}{\varepsilon_0}$ **1**

Alternatively

The surface integral of electric field over a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

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

(Award ½ marks for writing the formula only.)



½

(Gaussian surface can be cylindrical also)

As seen from figure, only two faces 1 and 2 will contribute to the flux. ½

Flux $\vec{E}.d\vec{s}$ through both the surfaces is equal and add up.

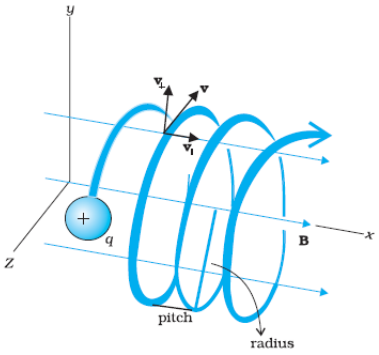
The charge enclosed by surface is σA, where σ is surface charge density

According to Gauss's theorem

$2EA=\sigma A/\varepsilon_0$ ½

$E=\sigma/2\varepsilon_0$

$\vec{E}=\frac{\sigma}{2\varepsilon_0}\hat{n}$ where n̂ is unit vector directed normally out of the plane ½

	(ii) $\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$ According to question E_1 (at point P) $= \frac{\lambda_1}{2\pi\varepsilon_0 r_1}$ $\vec{E} = \frac{10\times10^{-6}}{2\pi\varepsilon_0(10\times10^{-2})}\ (-\hat{j})\ N/C$ E_2 (at point P) $= \frac{\lambda_2}{2\pi\varepsilon_0 r_2}$ $\vec{E} = \frac{20\times10^{-6}}{2\pi\varepsilon_0(20\times10^{-2})}\ (-\hat{j})\ N/C$ $E_{net} = \frac{10\times10^{-6}}{2\pi\varepsilon_0}\left(\frac{1}{0.1}+\frac{2}{0.2}\right)(-\hat{j})\ N/C$ $= 3.6\times10^{6}\ (-\hat{j})\ N/C$ $\vec{F}_{net} = q\times\vec{E}_{net}$ $\vec{F} = -1.6\times10^{-19}\times3.6\times10^{6}\ (-\hat{j})\ N$ $= 5.76\times10^{-13}\ N\ (\hat{j})$	½ ½ ½ ½	5
33.	**(a)** (i) Showing helical path 1 ½ Obtaining frequency of revolution 1 ½ (ii) Finding magnetic moment of electron 2  $v_\perp = v\sin\theta$ is perpendicular to $\vec{B}$ and $v_\parallel = v\cos\theta$ is parallel to $\vec{B}$ Due to $v_\perp$ the charge describes circular path and $v_\parallel$ pushes it in the direction of $\vec{B}$. Therefore under the combined effect of two components the charged particle describes helical path, as shown in the figure. The centripetal force $\frac{mv_\perp^2}{r} = B\,qv_\perp$ $v_\perp = \frac{Bqr}{m}$ $(v_\perp = v\sin\theta)$ Time period = T $= \frac{2\pi r}{v_\perp}$	½ **1** ½ ½	

$= \frac{2\pi m}{Bq}$

$frequency\, v = \frac{1}{T} = \frac{Bq}{2\pi m}$ ½

(ii) Magnetic moment $m = I\,A$

$I = \frac{e}{T} = ev$

$= 1.6\times10^{-19}\times8\times10^{14}$ ½

$= 1.28\times10^{-4}\,A$

$M = 1.28\times10^{-4}\times3.14\times(2\times10^{-10})^2$ ½

$= 5.12\pi\times10^{-24}\,Am^2 = 1.6\times10^{-23}\,Am^2$ ½

OR

(b)

(i) Definition of current sensitivity	1
Showing dependence of current sensitivity & explanation	1+1
(ii) Calculation of resistance	2

(i) Deflection produced per unit current is called its current sensitivity. **1**

$I_S = \frac{\theta}{I} = \frac{NBA}{K}$

Current sensitivity can be increased by

(a) increasing number of turns in coil

(b) increasing area of coil in magnetic field **1**

(c) decreasing K (Torsional Constant)

(any one)

$V_s = \frac{\theta}{V} = \frac{NBA}{KR}$

If current sensitivity is increased by increasing number of turns of the coil, the resistance of the galvanometer will also increase. Thus voltage sensitivity may not increase. **1**

(ii) $V = I_G(R+G)$

$R = \frac{V}{I_G} - G$ ½

$= \frac{100}{20\times10^{-3}} - 15$ ½

$= 5000 - 15$

$= 4985\Omega$ ½

By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V) ½ 5

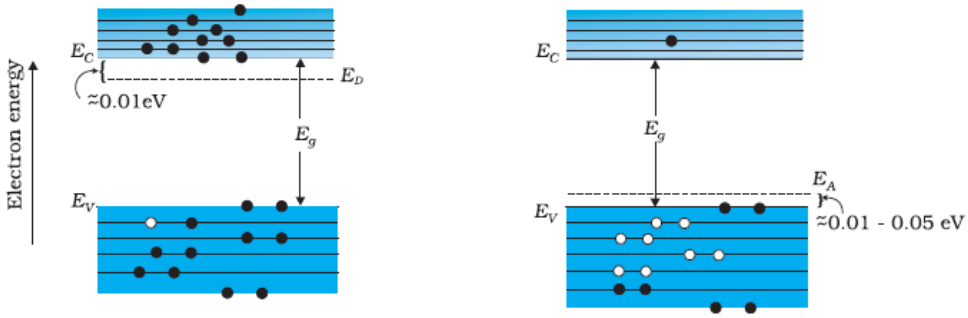
Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT- PHYSICS (CODE 55/2/3)

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

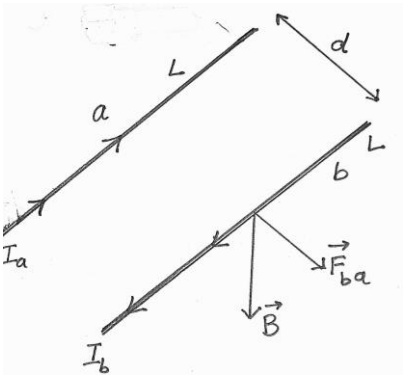
	retained and the other answer scored out with a note **"Extra Question"**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0 – 70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every 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 :55/2/3			
Q.No	**VALUE POINTS/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION-A		
1.	(D) $\frac{1}{3}$	**1**	**1**
2.	(A) $\frac{v_d}{2}$	**1**	**1**
3.	(B) Resistance of the coil	**1**	**1**
4.	(C) 31.4μWb	**1**	**1**
5.	(D) Magnetic Flux and Power both	**1**	**1**
6.	(A) $\frac{5\pi}{6}$	**1**	**1**
7.	(C) III	**1**	**1**
8.	(B) $8x10^{-28}$	**1**	**1**
9.	(C) P	**1**	**1**
10.	(B) $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{1}{\lambda_3}$	**1**	**1**
11.	(B) The barrier height increases and the depletion region widens.	**1**	**1**
12.	(C) $\frac{1}{K}$	**1**	**1**
13.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
14.	(C) Assertion(A) is true, but Reason (R) is false	**1**	**1**
15.	(B) Both Assertion(A) and Reason (R) are true but Reason(R) is not the correct explanation of the Assertion (A)	**1**	**1**
16.	(A) Both Assertion(A) and Reason (R) are true and Reason(R) is the correct explanation of the Assertion (A)	**1**	**1**
	SECTION- B		
17.	Deriving relation 2 $V = IR$ $El = \frac{I\rho l}{A}$ (V= El, $R = \frac{\rho l}{A}$) $E = \frac{I}{A}\rho$ $E = \sigma\rho$	½ ½ ½ ½	**2**
18.	Effect on energy gap and justification (i) Trivalent impurity ½ + ½ (ii) Pentavalent impurity ½ + ½ (i) Decreases Justification: An acceptor energy level is formed just above the top of the valence band.	½ ½	

	(ii) Decreases Justification: A donor level is formed just below the bottom of conduction band. **Alternatively**  **(Note : Award the credit of justification if a student draws band diagram)**	½ ½	**2**
19.	**(a)** Obtaining expression for resultant intensity 2 $x_1 = a\cos\omega t$ $x_2 = a\cos(\omega t + \phi)$ $x = x_1 + x_2$ $= a(\cos\omega t + \cos(\omega t + \phi))$ $= a(2\cos(\omega t + \frac{\phi}{2})\cos\frac{\phi}{2})$ $= 2a\cos\frac{\phi}{2}\cos(\omega t + \frac{\phi}{2})$ Intensity I = K (amplitude) ^{2} where K is a constant. $= K(2a\cos\frac{\phi}{2})^2$ $= 4I_0\cos^2\frac{\phi}{2}$ $I_o = Ka^2$ = intensity of each incident wave. **(Award full credit of this part for all other alternative correct methods)** **OR** **(b)** Effect and justification (i) Source slit moved closer to plane of slits 1 (ii) Separation between two slits 1 (i)Sharpness of interference pattern decreases $\frac{s}{S} < \frac{\lambda}{d}$ As S decreases, interference patterns produced by different parts of the source overlap and finally fringes disappear. **Alternatively** As the source slit is brought closer to the plane of the slits, the screen gets illuminated uniformly and fringes disappear.	½ ½ ½ ½ **1**	

	Alternatively Interference pattern is not formed. **(Note : Award full credit of this part if a student merely attempts this part.)** (ii) $\beta = \frac{\lambda D}{d}$ As d increases, β decreases and fringes disappear.	½ ½	**2**
20.	Finding ratio of period of revolution 2 $T = \frac{2\pi r_n}{v_n}$ $r_n \alpha n^2$ $v_n \alpha \frac{1}{n}$ $T \alpha n^3$ $\frac{T_2}{T_1} = \frac{(n_2)^3}{(n_1)^3}$ $= \frac{(2)^3}{(1)^3}$ $= \frac{8}{1}$	½ ½ ½ ½	**2**
21.	Finding focal length 1 ½ Nature of the lens ½ For convex lens in air $\frac{1}{f_a} = \left(\frac{n_g}{n_a} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ For convex lens in liquid. $\frac{1}{f_l} = \left(\frac{n_g}{n_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\frac{f_l}{f_a} = \frac{\frac{1.52-1}{1}}{\frac{1.52-1.65}{1.65}}$ $= -6.6$ $f_l = -6.6\ f_a$ $= -99$cm Nature of the lens: Diverging/ behaves like a concave lens.	½ ½ ½ ½	**2**
	SECTION- C		
22.	**(a)** Explaining nature of force ½ Obtaining expression of force 1½ Defining one ampere 1		

Nature of force is repulsive. ½



½

Magnetic field due to current I_a at all points of conductor b

$B_{ab} = \frac{\mu_0 I_a}{2\pi d}$ directed downwards ½

Force experienced by conductor b on its segment of length l

$F_{ab} = I_b l B_{ab}$

$= \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards left ½

Similarly

Force experienced by conductor a on its segment of length l

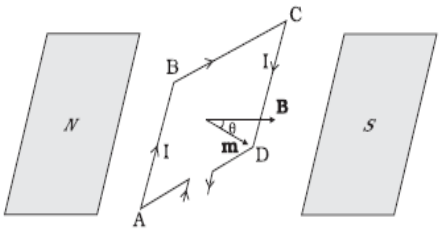
$F_{ba} = \frac{\mu_0 I_a I_b}{2\pi d} l$ directed towards right

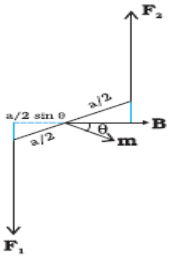
One ampere is that steady current which when maintained in each of two very long straight parallel conductors of negligible cross- section, placed one metre apart in vacuum produces a force of 2×10^{-7} N/m on each conductor. **1**

OR

(b)

Obtaining expression of torque	2
Drawing diagram	1





1

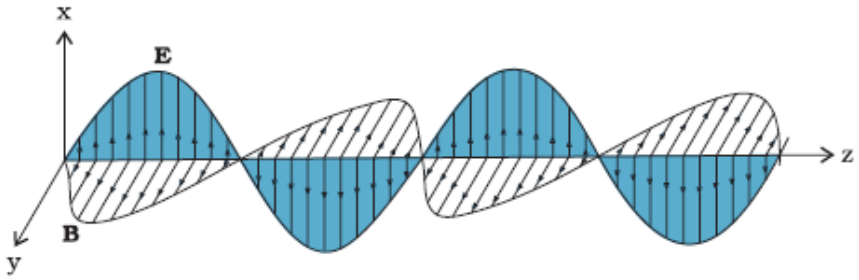
½

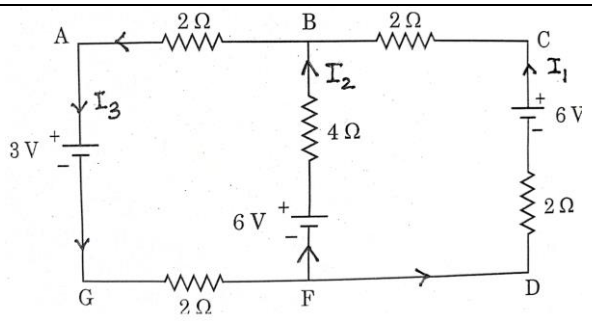
Forces on arm BC and DA are equal and opposite and act along the axis of the coil. Being collinear they cancel each other.

Forces on arms AB and CD are equal and opposite but not collinear. They form a couple. ½

$F_1 = F_2 = IbB$

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

	$\tau = IabB\sin\theta$ $\tau = IAB\sin\theta$ (where A = ab & m = IA) $\vec{\tau} = \vec{m} \times \vec{B}$	½	**3**
23.	(a) Factors affecting speed of Electromagnetic wave 1 (b) Production of Electromagnetic wave 1 (c) Sketch of Electromagnetic wave 1		
	(a) Speed of EM waves $v = \frac{1}{\sqrt{\mu\varepsilon}}$ Speed depends upon (i) Permittivity (ε) of medium (ii) Magnetic permeability (μ) of medium	½ + ½	
	(b) Accelerated charges or oscillating charges produce electromagnetic waves	**1**	
	(c)  	**1**	**3**
24.	(a) Finding output voltage 1 (b) Finding instantaneous voltage 1 (c) Finding current 1		
	(a) $V_P(\text{rms}) = \frac{140}{\sqrt{2}} = \frac{140}{1.4} = 100V$	½	
	$\therefore V_s = \frac{N_s}{N_p} V_p = \frac{1000}{200} 100 = 500V$	½	
	(b) $v_s = 500\sqrt{2}\sin 100\,pt = 700\sin 100\,pt$	**1**	
	(c) Power Output = Power Input $I_s = \frac{5000}{500} = 10A$	**1**	**3**
25.	Finding magnitude and direction of current in AG, BF and CD 1+1+1		



By Kirchoff's Laws (at point B)

$I_1 + I_2 = I_3$ .....(1) ½

In the closed loop AGFBA

$3 + 2I_3 - 6 + 4I_2 + 2I_3 = 0$ ½

$I_2 + I_3 = \frac{3}{4}$ .....(2)

From (i) ½

$2I_1 + I_2 = \frac{3}{4}$ .....(3)

In closed loop BFDCB ½

$-4I_2 + 6 + 2I_1 - 6 + 2I_1 = 0$

$I_2 - I_1 = 0$

$I_2 = I_1$ .....(4)

Putting in (3) ½

$I_1 = \frac{1}{4} A$

From (4)

$I_2 = \frac{1}{4} A$

From (2) $I_3 = \frac{1}{2} A$ ½ **3**

26.

(a) Three characteristics	1 ½
(b) Identifying more stable nucleus and reason	1 ½

(a) Characteristics of nuclear forces :-

1. Saturated in nature
2. Attractive for distances larger than r_0 and repulsive for distance less than r_o
3. Do not depend on nature of electric charge i.e. same for n-n, n-p and p-p pairs.
4. Much stronger than gravitational forces.

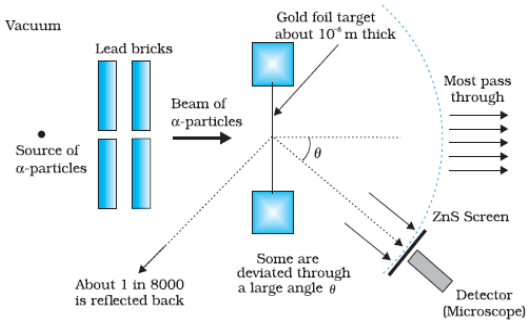
(Any three) **1½**

(b) $^{8}_{4}X$ is more stable ½

The ratio of number of neutrons to the number of protons is more in $^{8}_{4}X$ than $^{5}_{3}Y$ **1** **3**

27.

(a) Drawing schematic arrangement	1
(b) Explaining conclusions	1
(c) Defining distance of closest approach	1



1

(b) -Entire positive charge and most of the mass of atom are concentrated in the nucleus.
- Electrons move in orbits about the nucleus just as planets around the sun.
- Size of nucleus is about 10^{-15}m to 10^{-14}m.
- Most of the space in an atom is empty.

1

(c) The distance of the α particle from the centre of nucleus at which the whole of the initial kinetic energy of the particle gets converted into the electric potential energy.

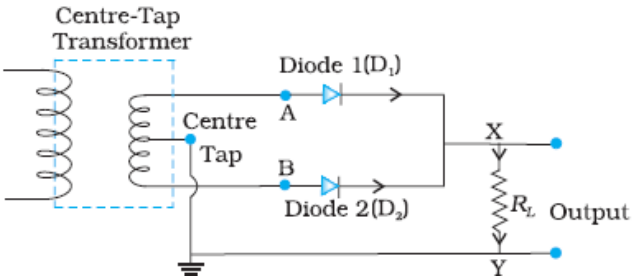
1 **3**

Alternatively

The distance of the α particle from the centre of nucleus at which it stops momentarily and reverses its direction.

28.

Explaining working of full wave rectifier	2
Drawing input and output wave forms	1



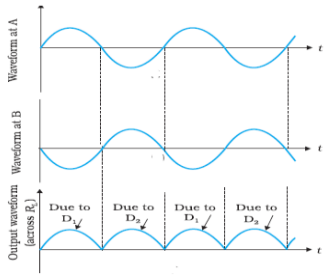
1

When input voltage at 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, during the positive half cycle diode D_1 gets forward biased and conducts while diode D_2 gets reverse biased and does not conduct.
Hence during positive half cycle an output current and output voltage across R_L is obtained.

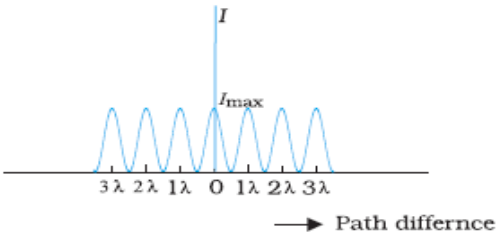
½

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.
We get output voltage in both positive and negative half cycles.

½

		1	3
29.	(i) Since no option is correct, award 1 mark to all students. (ii) (D) 800 nm (iii) (a) (A) $\frac{\sqrt{3}}{2}$ **OR** (b) (B) $\sin^{-1}\left(\frac{4}{5}\right)$ (iv) (A) $\sin^{-1}\sqrt{n^2-1}$	1 1 1 1	 4
30.	(i) (B) The internal resistance of a cell decreases with the decrease in temperature of the electrolyte. (ii) (B) 2.8 V (iii) (A) $\varepsilon = V_+ + V_- > 0$ (iv) (a) (D) 0.2A **OR** (b) (A) 1.0Ω	1 1 1 1	 4
31.	**(a)** (i) Two differences between interference pattern and diffraction pattern 2 (ii) Intensity distribution graph 1 (iii) Finding intensity of light 2 (i) (ii) (iii) Path difference $(\Delta) = \lambda$	1 + 1 1	

	Interference	Diffraction
1	Bands are equally spaced	Bands are not equally spaced.
2	Intensity of bright bands is same.	Intensity of maxima decreases on either side of central maxima.
3	First maxima is at an angle λ / a	First minima is at an angle λ / a



$$\phi = \frac{2\pi\Delta}{\lambda}$$

$$\phi = 2\pi$$

$$I = 4I_0 \cos^2 \frac{\phi}{2}$$

$$K = 4I_0 \cos^2 \pi \ = 4I_0$$ ½

$$\text{Path difference} = \frac{\lambda}{6}$$

$$\phi = \pi / 3$$

$$I = 4I_0 \cos^2 \frac{\pi}{6}$$ ½

$$= 4I_0 \times \frac{3}{4}$$

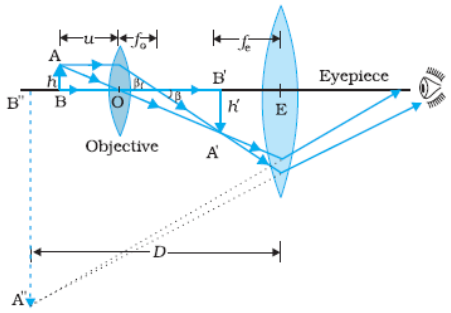
$$= \frac{3}{4}\text{K}$$ ½

OR

(b)

(i)	Drawing labeled ray diagram	1
	Derivation of magnifying power	2
(iii)	Finding magnifying power	2

(i)



1

The magnification obtained by eye-piece lens $m_e = \left(1 + \frac{D}{f_e}\right)$ ½

The magnification obtained by objective lens $m_0 = \frac{v_0}{-u_0}$ ½

Hence the total magnifying power is

$m = m_0 \times m_e$ ½

$= \frac{v_0}{-u_0}\left(1 + \frac{D}{f_e}\right)$ ½

$(ii)\ \text{m} = \left|\frac{f_0}{f_e}\right|$ **1**

Identification of focal length of objective and eyepiece

$f_0 = 100cm$

$f_e = 5cm$ ½

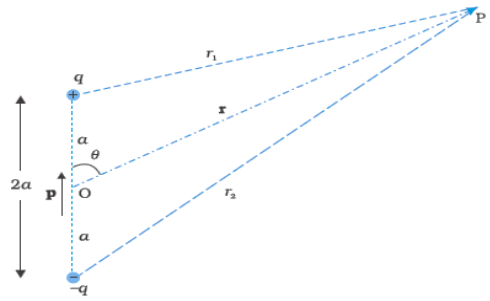
$m = \left|\frac{100}{5}\right| = 20$ ½ **5**

32.

(a)

(i) Obtaining expression for electric potential	3
(ii) Finding the value of n	2

(i)



½

Potential due to the dipole is the sum of potentials due to charges q and -q

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right) \quad \text{----------(1)}$$ ½

By geometry

$$r_1^2 = r^2 + a^2 - 2ar\cos\theta$$

$$r_2^2 = r^2 + a^2 + 2ar\cos\theta$$ ½

For r >> a, retaining terms only up to first order in a/r

$$r_1^2 = r^2\left(1 - \frac{2a\cos\theta}{r} + \frac{a^2}{r^2}\right)$$

$$\cong r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$

Similarly

$$r_2^2 \cong r^2\left(1 + \frac{2a\cos\theta}{r}\right)$$ ½

Using the binomial theorem and retaining terms up to the first order in a/r

$$\frac{1}{r_1} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-1/2}$$

$$\cong \frac{1}{r}\left(1 + \frac{a\cos\theta}{r}\right) \quad \text{----------(2)}$$

$$\frac{1}{r_2} \cong \frac{1}{r}\left(\frac{1 + 2a\cos\theta}{r}\right)^{-1/2} \quad \text{----------(3)}$$

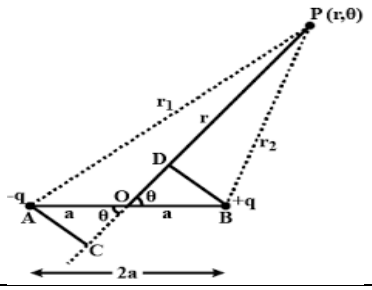
$$\cong \frac{1}{r}\left(1 - \frac{a\cos\theta}{r}\right)$$ ½

Using eqn. (1) (2), (3) and p = 2qa

$$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2}$$

$$= \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$ ½

Alternatively –



½

$r_2 = r + a\cos\theta$

$r_1 = r - a\cos\theta$

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ ½

$V = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r - a\cos\theta} - \frac{1}{r + a\cos\theta}\right)$ ½

$= \frac{q}{4\pi\varepsilon_0}\left(\frac{2a\cos\theta}{r^2 - a^2\cos^2\theta}\right)$ ½

$= \frac{p}{4\pi\varepsilon_0 r^2}\left(\frac{\cos\theta}{1 - \frac{a^2}{r^2}\cos^2\theta}\right)$ ½

For r>>a, neglecting $\frac{a^2}{r^2}$

V= $\frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$ ½

(ii) Consider the side of equilateral triangle as 'a'

Potential energy = U= $\frac{kq_1q_2}{a} + \frac{kq_2q_3}{a} + \frac{kq_1q_3}{a}$ ½

According to question

$U = \frac{k(q)(2q)}{a} + \frac{k(2q)(nq)}{a} + \frac{k(q)(\text{n } q)}{a} = 0$ ½

$= \frac{2q^2}{a} + \frac{2nq^2}{a} + \frac{\text{n } q^2}{a} = 0$

$2 + 2n + n = 0$ ½

$3n = -2$

$n = -\frac{2}{3}$ ½

OR

(b)

(i) Statement of Gauss's Law	1
Obtaining expression for electric field	2
(ii) Finding net force on electron	2

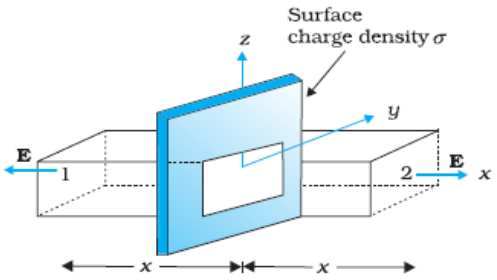
(i) Electric Flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$, where q is the total charge enclosed by the surface. $\phi = \frac{q}{\varepsilon_0}$ **1**

Alternatively

The surface integral of electric field over a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

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

(Award ½ mark for writing the formula only.)



(Gaussian surface can be cylindrical also) ½

As seen from figure, only two faces 1 and 2 will contribute to the flux.

Flux $\vec{E}.d\vec{s}$ through both the surfaces is equal and add up. ½

The charge enclosed by surface is σA, where σ is surface charge density

According to Gauss's theorem ½

$2EA = \sigma A / \varepsilon_0$ ½

$E = \sigma / 2\varepsilon_0$

$\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ where n̂ is unit vector directed normally out of the plane

(ii) $\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$

According to question

E_1 (at point P) $= \frac{\lambda_1}{2\pi\varepsilon_0 r_1}$

$= \frac{10\times10^{-6}}{2\pi\varepsilon_0(10\times10^{-2})}(-\hat{j})\ N/C$ ½

E_2 (at point P) $= \frac{\lambda_2}{2\pi\varepsilon_0 r_2}$

$= \frac{20\times10^{-6}}{2\pi\varepsilon_0(20\times10^{-2})}(-\hat{j})\ N/C$ ½

$E_{net} = \frac{10\times10^{-6}}{2\pi\varepsilon_0}\left(\frac{1}{0.1}+\frac{2}{0.2}\right)(-\hat{j})\ N/C$

$= 3.6\times10^{6}\ (-\hat{j})\ N/C$ ½

$F_{net} = q\times E_{net}$

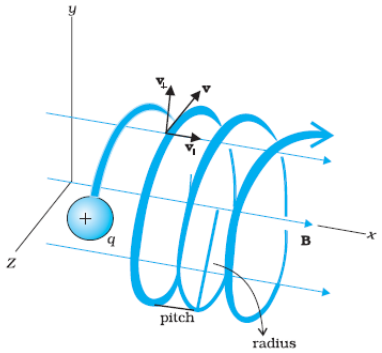
$= -1.6\times10^{-19}\times3.6\times10^{6}(-\hat{j})\ N$

$= 5.76\times10^{-13}N\ (\hat{j})$ ½ 5

33.

(a)

(i) Showing helical path	1 ½
Obtaining frequency of revolution	1 ½
(ii) Finding magnetic moment of electron	2



½

$v_\perp = v\sin\theta$ is perpendicular to $\vec{B}$ and

$v_\parallel = v\cos\theta$ is parallel to $\vec{B}$

Due to $v_\perp$ the charge describes circular path and $v_\parallel$ pushes it in the direction of $\vec{B}$. Therefore under the combined effect of two components the charged particle describes helical path, as shown in the figure. **1**

The centripetal force

$$\frac{mv_\perp^2}{r} = B\,qv_\perp$$ ½

$$v_\perp = \frac{Bqr}{m} \qquad (v_\perp = v\sin\theta)$$ ½

Time period = $T = \frac{2\pi r}{v_\perp}$

$= \frac{2\pi m}{Bq}$

$$frequency\ v = \frac{1}{T} = \frac{Bq}{2\pi m}$$ ½

(ii) Magnetic moment $m = I\,A$

$I = \frac{e}{T} = ev$ ½

$= 1.6\times10^{-19}\times8\times10^{14}$

$= 1.28\times10^{-4}\,A$ ½

$M = 1.28\times10^{-4}\times3.14\times(2\times10^{-10})^2$ ½

$= 5.12\pi\times10^{-24}\,Am^2 = 1.6\times10^{-23}\,Am^2$ ½

OR

(b)

(i) Definition of current sensitivity	1
Showing dependence of current sensitivity & explanation	1+1
(ii) Calculation of resistance	2

(i) Deflection produced per unit current is called its current sensitivity. **1**

$I_S = \frac{\theta}{I} = \frac{NBA}{K}$

Current sensitivity can be increased by

(a) increasing number of turns in coil

	(b) increasing area of coil in magnetic field (c) decreasing K (Torsional Constant) **(any one)** $V_s = \frac{\theta}{V} = \frac{NBA}{KR}$ If current sensitivity is increased by increasing number of turns of the coil, the resistance of the galvanometer will also increase. Thus voltage sensitivity may not increase. (ii) $V = I_G(R+G)$ $R = \frac{V}{I_G} - G$ $= \frac{100}{20\times10^{-3}} - 15$ $= 5000 - 15$ $= 4985\Omega$ By connecting 4985Ω in series with galvanometer it is converted to voltmeter of range (0-100V)	**1** **1** ½ ½ ½ ½	**5**