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.

नोट	NOTE
(I) कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **12** हैं ।	(I) Please check that this question paper contains **12** printed pages.
(II) प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को छात्र उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।	(II) 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.
(III) कृपया जाँच कर लें कि इस प्रश्न-पत्र में **12** प्रश्न हैं ।	(III) Please check that this question paper contains **12** questions.
(IV) **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, 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 candidates will read the question paper only and will not write any answer on the answer-book during this period. *

भौतिक विज्ञान (सैद्धान्तिक)

PHYSICS (Theory)

निर्धारित समय : *2 घण्टे*
Time allowed : 2 hours

अधिकतम अंक : *35*
Maximum Marks : 35

सामान्य निर्देश :

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

(i)   *इस प्रश्न पत्र में कुल 12 प्रश्न हैं ।* **सभी** *प्रश्न अनिवार्य हैं ।*

(ii)   *यह प्रश्न पत्र* **तीन** *खंडों में विभाजित है – खंड क, ख और ग ।*

(iii) **खण्ड-क :** *प्रश्न संख्या 1 से 3 प्रत्येक प्रश्न 2 अंक का है ।*

(iv)   **खण्ड-ख :** *प्रश्न संख्या 4 से 11 तक प्रत्येक प्रश्न 3 अंक का है ।*

(v)   **खण्ड-ग :** *प्रश्न संख्या 12 प्रकरण अध्ययन आधारित प्रश्न है, यह प्रश्न 5 अंक का है ।*

(vi)   *प्रश्न पत्र में कोई समग्र विकल्प नहीं है । हालाँकि कुछ प्रश्नों में आंतरिक विकल्प प्रदान किए गए हैं । इनमें से केवल एक ही प्रश्न का उत्तर लिखिए ।*

(vii) *लॉग टेबल का उपयोग कर सकते हैं, यदि आवश्यक हो, लेकिन कैल्कुलेटर के उपयोग की अनुमति नहीं है ।*

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

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

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

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

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

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

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

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

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

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

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

General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) *This question paper contains 12 questions. **All** questions are compulsory.*

(ii) *This question paper is divided into three sections – Section A, B and C.*

(iii) **Section A :** *Q. Nos. **1** to **3** are of **2** marks each.*

(iv) **Section B :** *Q. Nos. **4** to **11** are of **3** marks each.*

(v) **Section C :** *Q. No. **12** is a case study based question of **5** marks.*

(vi) *There is no overall choice in the question paper. However, internal choice has been provided in some of the questions. Attempt any one of the alternatives in such questions.*

(vii) *Use of log tables is permitted, if necessary, but use of calculator is not permitted.*

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

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

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

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

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

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

Mass of electron (m_e) = 9.1×10^{-31} kg

Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

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

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

खण्ड – क

1. (a) गाइगर-मार्सडेन प्रयोग में प्रकीर्णन कोण (θ) के साथ प्रकीर्णित अल्फा कणों की संख्या (N) का विचरण दर्शाने वाला ग्राफ खींचिए । इस ग्राफ से दो निष्कर्ष निकालिए । **2**

अथवा

(b) आपतित विकिरणों के लिए संग्राही प्लेट विभव के साथ प्रकाश-विद्युत धारा का विचरण दर्शाने के लिए उचित ग्राफ खींचिए :

(i) विकिरणों की समान तीव्रता परन्तु विभिन्न आवृत्तियाँ v_1, v_2 और v_3 ($v_1 < v_2 < v_3$)

(ii) विकिरणों की समान आवृत्ति परन्तु विभिन्न तीव्रताएँ I_1, I_2 और I_3 ($I_1 < I_2 < I_3$)

2. नैज अर्धचालक और अपद्रव्यी अर्धचालक के बीच विभेदन कीजिए । यद्यपि किसी अपद्रव्यी अर्धचालक में $n_e \neq n_h$, तब भी यह विद्युत उदासीन होता है । क्यों ? **2**

3. दाता और ग्राही स्तरों को चित्रित करते हुए तापमान T > 0K पर n-प्रकार और p-प्रकार के अर्धचालकों के ऊर्जा बैण्ड आरेख खींचिए । इन स्तरों के महत्व का उल्लेख कीजिए । **2**

खण्ड – ख

4. (a) 600 nm तरंगदैर्ध्य का कोई समान्तर किरण पुन्ज 0.2 mm चौड़ाई की किसी झिर्री पर अभिलम्बवत आपतन करता है । यदि परिणामी विवर्तन पैटर्न का प्रेक्षण 1 m दूरी पर स्थित पर्दे पर किया जाता है, तो केंद्रीय उच्चिष्ठ से **3**

(i) प्रथम निम्निष्ठ की दूरी, तथा

(ii) द्वितीय उच्चिष्ठ की दूरी ज्ञात कीजिए ।

अथवा

(b) अपवर्तनांक μ_1 के पदार्थ से बना वक्रता त्रिज्या R का कोई पतला समोत्तल लेंस अपवर्तनांक μ_2 ($>\mu_1$) के समान वक्रता त्रिज्या के किसी समावतल लेंस के समाक्ष सम्पर्क में रखा गया है । ज्ञात कीजिए :

(i) इन लेंसों की क्षमताओं का अनुपात, और

(ii) इस लेंस संयोजन की क्षमता और उसकी प्रकृति ।

SECTION – A

1. (a) Draw the graph showing the variation of the number (N) of scattered alpha particles with scattering angle (θ) in Geiger – Marsden experiment. Infer two conclusions from the graph. **2**

    OR

    (b) Plot suitable graphs to show the variation of photoelectric current with the collector plate potential for the incident radiation of

    (i)   the same intensity but different frequencies v_1, v_2 and v_3 ($v_1 < v_2 < v_3$)

    (ii) the same frequency but different intensities I_1, I_2 and I_3 ($I_1 < I_2 < I_3$)

2. Distinguish between intrinsic and extrinsic semiconductors. Although in an extrinsic semiconductor $n_e \neq n_h$, yet it is electrically neutral. Why ? **2**

3. Draw energy band diagrams of n-type and p-type semiconductors at temperature T > 0K, depicting the donor and acceptor energy levels. Mention the significance of these levels. **2**

SECTION – B

4. (a) A parallel beam of light of wavelength 600 nm is incident normally on a slit of width 0.2 mm. If the resulting diffraction pattern is observed on a screen 1 m away, find the distance of **3**

    (i)   first minimum, and

    (ii) second maximum, from the central maximum.

    OR

    (b) A thin equiconvex lens of radius of curvature R made of material of refractive index μ1 is kept coaxially, in contact with an equiconcave lens of the same radius of curvature and refractive index μ 2 (> μ1). Find :

    (i)   the ratio of their powers, and

    (ii) the power of the combination and its nature.

5. उपगमन की समीपस्थ दूरी की परिभाषा लिखिए । यदि किसी α-कण की गतिज ऊर्जा दो गुनी कर दी जाए तो इस दूरी पर क्या प्रभाव पड़ेगा ? **3**

6. हाइगेन्स सिद्धान्तों का उपयोग करके किसी समतल परावर्तक पृष्ठ पर आपतित समतल तरंगाग्र का परावर्ती तरंगाग्र खींचिए और परावर्तन के नियमों का सत्यापन कीजिए । **3**

7. किसी इलेक्ट्रॉन से संबद्ध द ब्राग्ली तरंगदैर्ध्य 0.30 nm है । इस इलेक्ट्रॉन की (a) चाल तथा (b) गतिज ऊर्जा (eV में) परिकलित कीजिए । **3**

8. नीचे दी गयी अभिक्रिया में मुक्त हुई ऊर्जा MeV में परिकलित कीजिए : **3**

$$^2_1H + {}^3_1H \longrightarrow {}^4_2He + n$$
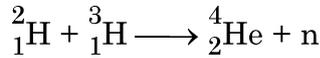
दिया है : $m\left({}^2_1H\right) = 2.014102$ u

$m\left({}^3_1H\right) = 3.016049$ u

$m\left({}^4_2He\right) = 4.002603$ u

$m_n = 1.008665$ u

9. (a) (i) दो माध्यमों को पृथक करने वाले किसी पृष्ठ पर कोई एकवर्णी प्रकाश आपतन कर रहा है । अपवर्तन के पश्चात् इस प्रकाश की आवृत्ति प्रभावित नहीं होती परन्तु इसकी तरंगदैर्ध्य परिवर्तित हो जाती है । क्यों ? **3**

   (ii) किसी विद्युत-चुम्बकीय विकिरण की आवृत्ति 1.0×10^{11} Hz है । इस विकिरण को पहचानिए और इसके दो उपयोग लिखिए ।

   अथवा

   (b) (i) प्रकाश किरण PQ के पथ को आरेखित कीजिए जो आरेख में दर्शाए अनुसार कोण A के किसी काँच के प्रिज़्म के एक फलक पर किसी कोण i पर आपतन करती है । इसके पश्चात् यह किरण दूसरे फलक से कोण e पर निर्गत होती है । इस किरण आरेख का उपयोग यह सिद्ध करने के लिए कीजिए कि जिस कोण पर किरण विचलित होती है वह कोण $\angle \delta = \angle i + \angle e - \angle A$ द्वारा दिया गया है ।

   (ii) $\angle \delta$ का निम्नतम मान क्या होगा जब किरण प्रिज़्म के भीतर से सममितत: गुजरती है ?

5. Define the term – Distance of closest approach. How will it be affected, for an α - particle, if kinetic energy of the particle is doubled ? **3**

6. Using Huygen's principle, for a plane wavefront incident on a plane reflecting surface, draw the reflected wavefront. Hence prove laws of reflection. **3**

7. The de-Broglie wavelength associated with an electron is 0.30 nm. Calculate : (a) the speed, and (b) the kinetic energy (in eV), of the electron. **3**

8. Calculate the energy released in MeV in the following reaction : **3**

$$^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + n$$
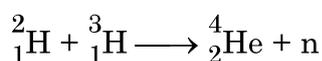
Given : $m\left({}^{2}_{1}H\right) = 2.014102$ u

$m\left({}^{3}_{1}H\right) = 3.016049$ u

$m\left({}^{4}_{2}He\right) = 4.002603$ u

$m_n = 1.008665$ u

9. (a) (i) Monochromatic light is incident on a surface separating two media. The frequency of the light after refraction remains unaffected but its wavelength changes. Why ? **3**

   (ii) The frequency of an electromagnetic radiation is 1.0×10^{11} Hz. Identify the radiation and mention its two uses.

   OR

   (b) (i) Trace the path of a ray of light PQ which is incident at an angle i on one face of a glass prism of angle A. It then emerges out from the other face at an angle e. Use the ray diagram to prove that the angle through which the ray is deviated is given by $\angle\delta = \angle i + \angle e - \angle A$.

   (ii) What will be the minimum value of δ if the ray passes symmetrically through the prism ?

10. किसी LED के कार्यकारी सिद्धान्त का उल्लेख कीजिए । LED के दो महत्वपूर्ण लाभ और दो हानियाँ लिखिए । **3**

11. अपवर्तनांक $\sqrt{3}$ के किसी काँच के प्रिज्म के लिए न्यूनतम विचलन कोण δ प्रिज्म कोण A के बराबर है । प्रिज्म कोण A का मान ज्ञात कीजिए । यदि इस प्रिज्म को पानी में डुबो दें, तो कोण δ पर क्या प्रभाव होगा ? **3**

खण्ड – ग
प्रकरण अध्ययन

12. अध्यारोपण के सिद्धान्त का उपयोग प्रकाश तरंगों के व्यतिकरण की व्याख्या करने में किया जाता है । यह सिद्धान्त उल्लेख करता है कि किसी विशेष बिन्दु पर कई तरंगों द्वारा उत्पन्न परिणामी विस्थापन प्रत्येक तरंग द्वारा उत्पन्न अलग–अलग विस्थापनों का सदिश योग होता है । दो कलासंबद्ध प्रकाश तरंग स्रोत व्यतिकरण पैटर्न उत्पन्न करते है । थामस यंग ने किसी एकल एकवर्णी सूची छिद्र स्रोत (S) द्वारा प्रदिप्त दो सर्वसम सूची छिद्रों (S_1 और S_2) का उपयोग करके दो कलासंबद्ध स्रोत प्राप्त करने का तरीका व्युत्पन्न किया । इन स्रोतों का अपने प्रयोग में, जिसे यंग का द्वि–झिर्री प्रयोग कहते हैं, उपयोग करके यंग ने व्यतिकरण पैटर्न का अध्ययन किया । इस पैटर्न में एकान्तर (हर तीसरी) चमकीली और काली फ्रिंज होती हैं । दो क्रमागत चमकीली अथवा काली फ्रिंजों के बीच की दूरी S_1 और S_2 के बीच की दूरी, S_1S_2 तल से पर्दे की दूरी तथा उपयोग किए गए प्रकाश की तरंगदैर्ध्य पर निर्भर करती है । **5**

   I.   नीचे दी गयी तरंगों पर विचार कीजिए :

   (i) $y_1 = a \sin \omega t$

   (ii) $y_2 = a \sin 2\omega t$

   (iii) $y_3 = a \sin (2\omega t + \phi)$

   (iv) $y_4 = a \sin \left(4\omega t + \dfrac{\pi}{2} \right)$

   दो स्रोतों, S_1 और S_2 आने वाली तरंगों के किस युगल से व्यतिकरण होगा ?

   (A)   (i) और (ii)   (B)   (ii) और (iii)

   (C)   (iii) और (iv)   (D)   (iv) और (i)

10. State the working principle of an LED. Write any two important advantages and two disadvantages of LED.   **3**

11. For a glass prism of refractive index $\sqrt{3}$, the value of angle of minimum deviation δ is equal to the angle of prism A. Find the angle of prism A. How will the angle δ be affected if the prism were immersed in water ?   **3**

SECTION – C
CASE STUDY

12. The principle of superposition is used to understand the phenomenon of interference of light waves. The principle states that at a particular point, the resultant displacement produced by a number of waves is the vector sum of the displacements produced by each wave. Light waves from two coherent sources produce interference pattern. Thomas Young devised a way to obtain two coherent sources using two identical pinholes (S_1 and S_2) illuminated by a single monochromatic pinhole source S. Using these sources in his experiment known as Young's double slit experiment, Young studied the interference pattern. The pattern consists of alternate bright and dark fringes. The distance between two successive bright or dark finges depends on the distance between S_1 and S_2, the distance of the screen from the plane of S_1S_2 and the wavelength of light used.   **5**

I. Consider the following waves :

   (i) $y_1 = a \sin \omega t$

   (ii) $y_2 = a \sin 2\omega t$

   (iii) $y_3 = a \sin (2\omega t + \phi)$

   (iv) $y_4 = a \sin \left(4\omega t + \dfrac{\pi}{2} \right)$

   Which pair of the waves coming from two sources S_1 and S_2 will produce interference ?

   (A) (i) and (ii)   (B) (ii) and (iii)

   (C) (iii) and (iv)   (D) (iv) and (i)

II. दो कलासंबद्ध स्रोतों से निर्गमन करने वाली दो प्रकाश तरंगें जिनमें प्रत्येक की तीव्रता समान I_0 है, जिनके बीच $\lambda/4$ का पथान्तर है, किसी बिन्दु पर मिलती है । इस बिन्दु पर परिणामी तीव्रता होगी

(A) शून्य

(B) I_0

(C) $2 I_0$

(D) $4 I_0$

III. वन्दना ने यंग का द्वि-झिर्री प्रयोग क्रमागत रूप से नारंगी, हरे और लाल प्रकाश का उपयोग करके किया । यदि इन तीनों प्रकरण में फ्रिन्ज चौड़ाई क्रमश: ω_1, ω_2 और ω_3 हैं, तो नीचे दिया गया कौन सा संबंध सही है ?

(A) $\omega_2 > \omega_1 > \omega_3$

(B) $\omega_1 > \omega_2 > \omega_3$

(C) $\omega_2 > \omega_3 > \omega_1$

(D) $\omega_3 > \omega_1 > \omega_2$

IV. यंग के द्वि-झिर्री प्रयोग में यदि झिर्री-पृथकन 0.8 mm है तथा व्यतिकरण पैटर्न झिर्रियों S_1 और S_2 के तल से 50 cm दूरी पर स्थित पर्दे पर प्राप्त होता है । यदि प्रथम चमकीली फ्रिन्ज केन्द्रीय उच्चिष्ठ से 0.4 mm दूरी पर बनती है, तो उपयोग किए गए प्रकाश की तरंगदैर्घ्य है

(A) 480 nm

(B) 560 nm

(C) 640 nm

(D) 680 nm

V. नीचे दिए गए प्रचालनों के कारण यंग के द्वि-झिर्री प्रयोग में फ्रिन्जों के कोणीय पृथकन पर होने वाले प्रभाव पर विचार कीजिए :

(i) पर्दे को झिर्रियों के तल से दूर ले जाने पर

(ii) फ्रिन्जों के प्रेक्षित होने तक दोनों झिर्रियों के बीच पृथकन में वृद्धि करना ।

नीचे दिया गया कौन सा विकल्प सही है ?

(A) यह दोनों प्रकरणों में नियत रहता है ।

(B) यह दोनों प्रकरणों में घट जाता है ।

(C) यह पहले प्रकरण में नियत रहता है परन्तु दूसरे प्रकरण में घट जाता है ।

(D) यह पहले प्रकरण में घटता है परन्तु दूसरे प्रकरण में नियत रहता है ।

II. Two light waves of the same intensity I_0 each, having a path difference of $\lambda/4$, emanating from two coherent sources, meet at a point. The resultant intensity at the point will be

(A) Zero (B) I_0

(C) $2I_0$ (D) $4I_0$

III. Vandana performs Young's double slit experiment by using orange, green and red lights successively. If the fringe widths measured in the three cases are ω_1, ω_2 and ω_3 respectively, then which of the following is correct ?

(A) $\omega_2 > \omega_1 > \omega_3$ (B) $\omega_1 > \omega_2 > \omega_3$

(C) $\omega_2 > \omega_3 > \omega_1$ (D) $\omega_3 > \omega_1 > \omega_2$

IV. In a Young's double slit experiment, the slit separation is 0.8 mm and the interference pattern is obtained on a screen kept 50 cm from the plane of the slits S_1 and S_2. If the first bright fringe is formed 0.4 mm from the central maximum, the wavelength of light used is

(A) 480 nm (B) 560 nm

(C) 640 nm (D) 680 nm

V. Consider the effect on the angular separation of the fringes in a Young's double slit experiment due to the following operations :

(i) the screen is moved away from the plane of the slits,

(ii) the separation between the two slits is increased till fringes are observed.

Which of the following options is correct ?

(A) It remains constant in both cases.

(B) It decreases in both cases.

(C) It remains constant in (i) but decreases in (ii).

(D) It decreases in (i) but remains constant in (ii).

256 C

*

Senior Secondary School Term II Examination, 2022
Marking Scheme – PHYSICS (SUBJECT CODE – 042)
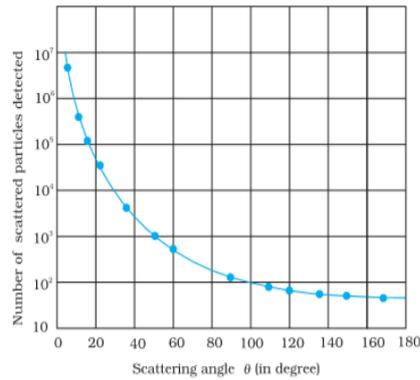**(PAPER CODE – 55/1/1)**

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Q. No.	EXPECTED ANSWER / VALUE POINTS	Marks	Total Marks
	SECTION—A		
1.	Energy band diagram ½ + ½ Significance 1		
		½ + ½	
	n-type **p-type**		
	Significance n-type semiconductors – small energy gap between donor level and conduction band which can be easily covered by thermally excited electrons.	½	
	p- type semiconductors - small energy gap between acceptor level and valence band which can be easily covered by thermally excited electrons.	½	
	Alternatively The conductivity of semiconductor is improved with the creation of donor and acceptor levels.		2

2(a).

Graph	1
Conclusions (any two)	½ + ½

(Give full credit if axis are marked and values are not given)

Conclusions
- Most of the alpha particles pass undeviated through the gold foil.
- A few alpha particles, get deflected through 90° or more.
- Only about 0.14% of the incident alpha particles are reflected by large angle.
- A very few alpha particles retrace their path.
  Any other two conclusions

1

½+½

2

OR

2(b).

i) Same intensity different frequency	1
ii) Same frequency different intensity	1

(i)   **(ii)**

1+1

2

3.			

<table>
<tr><td>Explanation</td><td>2</td></tr>
</table>

The unidirectional property of a diode makes it suitable for rectification. — 2

Alternatively

The diode conducts when forward biased and does not conduct when reverse biased.

(Award 1 mark if a student draws the forward and reverse characteristics of a diode.) — 2

SECTION- B

4.			

<table>
<tr><td>Definition of distance of closest approach</td><td>1 ½</td></tr>
<tr><td>Effect on distance of closest approach due to change in K.E.</td><td>1 ½</td></tr>
</table>

The minimum distance up to which an alpha particle travel along the central line of the nucleus before it rebounds is called distance of closest approach. — 1 ½

Alternatively

An alpha particle travelling directly towards the centre of a nucleus slows down as it approaches the nucleus due to repulsive force. At a distance r_0 from the nucleus, the α- particle stops and its total kinetic energy converts into electrostatic potential energy. This distance r_0 is called distance of closest approach.

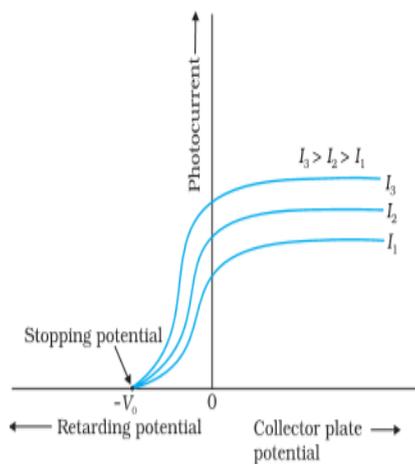$$r_0 = \frac{2Ze^2}{4\pi \in_0 K.E.}$$ — ½

i.e., $r_0 \propto \dfrac{1}{K.E.}$ — ½

as K is doubled , r_0 is halved. — ½

(Award full 1½ marks if a student writes r_0 is halved without writing formula) — 3

5.			

<table>
<tr><td>Finding distance from source</td><td>2</td></tr>
<tr><td>Finding nature of image</td><td>1</td></tr>
</table>

Relation for concave spherical surface

$$\frac{\mu_1}{-u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$$ — ½

$$\frac{1}{-u} + \frac{\mu}{v} = \frac{\mu - 1}{R}$$ — ½

$$\frac{1}{-(-24)} + \frac{1·5}{v} = \frac{1·5 - 1}{-60}$$ — ½

$\therefore v = -30$ cm

	Distance of image from point source = $-24-(-30)=6$ cm	½	3
	Nature of image = Virtual image	1	

6.

Calculation of mass defect	2
Calculation of energy released	1

$${}_{1}^{2}\text{H} + {}_{1}^{3}\text{H} \rightarrow {}_{2}^{4}\text{He} + n + Energy$$ ½

Mass defect = mass of reactants – mass of products   ½

$$\Delta m = m({}_{1}^{2}\text{H} + {}_{1}^{3}\text{H}) - m({}_{2}^{4}\text{He} + {}_{0}^{1}n)$$ ½

Mass defect $= (2\cdot014102 + 3\cdot016049) - (4\cdot002603 + 1\cdot008665)$

$= 5\cdot030151 - 5\cdot011268$

$= 0\cdot018883 u$ ½

Energy released = Δm × 931.5 MeV   ½

$= 0.018883 \times 931.5$ MeV

$= 17\cdot58$ MeV   ½   3

7.

Principle of optical fibre	1
Diagram of TIR	1
Use of optical fibre	½ +½

An optical fibre works on the principle of Total internal reflection.   1

Alternatively

Uses of optical fibres(any two)

   i)   Medical and optical examination (endoscopy).
   ii)   Transmission and reception of signals   ½+½   3
   iii)   Photometric sensors.

8(a).

Calculation of distance of first minimum	1 ½
Calculation of distance of second maximum	1 ½

(i) $y = \dfrac{\lambda D}{a}$ ½

$= \dfrac{600 \times 10^{-9} \times 1}{0.2 \times 10^{-3}}$ ½

$= 3 \times 10^{-3}\,\text{m} = 3 \text{ mm}$ ½

(ii) $y = (n + \dfrac{1}{2})\dfrac{\lambda D}{a}$ ½

$y = (2 + \dfrac{1}{2})\dfrac{\lambda D}{a}$ ½

$y = \dfrac{5}{2}\dfrac{\lambda D}{a}$

$y = \dfrac{5}{2} \times \dfrac{600 \times 10^{-9} \times 1}{0.2 \times 10^{-3}}$

$= 7.5 \times 10^{-3} = 7 \cdot 5 \text{ mm}$ ½

3

OR

8(b).

Finding the ratio of powers	1½
Finding the power of combination and nature	1½

(i) From $P = (\mu - 1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2} \right)$ ½

$P_1 = P_{convex} = (\mu - 1)\left(\dfrac{1}{R_1} - (-\dfrac{1}{R_2}) \right)$

$= (\mu - 1)(\dfrac{2}{R})$ ½

$P_2 = P_{concave} = (\mu - 1)\left(-\dfrac{1}{R_1} - \dfrac{1}{R_2} \right)$

$= -(\mu - 1)(\dfrac{2}{R})$

$\therefore \dfrac{P_1}{P_2} = \dfrac{(\mu_1 - 1)}{-(\mu_2 - 1)} = \dfrac{(\mu_1 - 1)}{(1 - \mu_2)}$ ½

(ii) $P = P_1 + P_2$ ½

$= (\mu_1 - 1)\left(\dfrac{2}{R} \right) + (-(\mu_2 - 1))\left(\dfrac{2}{R} \right)$

$P = \dfrac{2(\mu_1 - \mu_2)}{R}$ ½

As $\mu_2 > \mu_1$, P is negative ½

$\therefore$ Nature is diverging ½   3

9.			
	i) Calculation of energy of Radiation 1 ½ ii) Calculation of kinetic energy of photoelectron 1 ½		

i) Energy of incident radiation

$$E = h\nu = h\frac{c}{\lambda}$$ ½

$$= \frac{6\cdot 63 \times 10^{-34} \times 3 \times 10^{8}}{330 \times 10^{-9}}$$ ½

$$= 6\cdot 027 \times 10^{-19} \text{ J}$$ ½

ii) Kinetic energy of photoelectron

$$\text{K.E.} = E - \phi_0$$ ½

$$= (6\cdot 027 \times 10^{-19} - 3\cdot 5 \times 10^{-19}) \text{ J}$$ ½

$$= 2\cdot 527 \times 10^{-19} \text{ J}$$ ½   **3**

10.		
	Statement of working principle of LED 1 Advantages ½ + ½ Disadvantages ½ +½	

When the diode is forward biased, electrons are sent from n region to p region and holes are sent from p region to n region. At the junction the concentration of minority carriers increases. Thus at the junction, the excess minority carriers recombine with majority carriers and energy is released in the form of photons.   1

Advantages (any two):
 (i) Low operational voltage
(ii) Less power consumption
(iii) Fast action   ½+½
(iv) Long life and ruggedness
Disadvantages (any two) :
 (i) High cost
(ii) Can get damaged due to overheating   ½+½
(iii) Excess of voltage or current can damage LED   **3**

(Note: Award last 1 mark, even if disadvantages are not given.)

11(a).		
	i) Reason 1 ii) Identification of radiation 1 Uses ½ + ½	

i) Refraction arises through interaction of incident light with the atomic constituents of matter. Atoms may be viewed as oscillators which take up the frequency of the external agency causing forced oscillations. Thus the frequency of refracted light equals the frequency of incident light.   1

Alternatively

Frequency is the characteristic of the source of light. So it remains unaffected. But λ depends on refractive index (μ) of the medium as —

$$\lambda_m = \frac{\lambda_o}{\mu}$$

ii) Infrared/ Microwaves/ Radio waves   1

Uses of Infrared rays (any two)

- Remote control
- Green house effect
- Photography in foggy condition
- To reveal secret writings   ½ + ½
- Infrared lamps

Uses of Microwaves (any two)

- Radar System
- Geostationary satellite
- Microwave ovens

Uses of Radiowaves (any two)
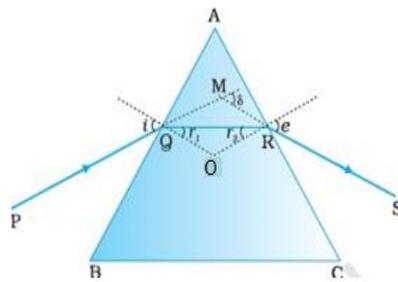
- TV transmission
- Radio broadcast   3
- Mobile transmission

11(b).

OR

i)Diagram	1
Proof of relation $\delta = (i+e) - A$	1 ½
ii)Finding minimum deviation	½

i) Diagram

1

$\delta = (i - r_1) + (e - r_2)$ ½

$\delta = (i + e) - (r_1 + r_2)$

In Quadrilateral AQOR
$\angle Q = \angle R = 90^\circ \qquad \therefore \angle A + \angle O = 180^\circ \qquad$ --------(1)   ½
In ΔQOR
$O + r_1 + r_2 = 180° \qquad$ --------(2)

Comparing (1) and (2)
$\therefore A = r_1 + r_2$

$\therefore \delta = (i + e) - A$ ½

	ii) If a ray passes symmetrically through a prism (parallel to base of prism), the value of angle of deviation is minimum. At this angle $\angle i = \angle e$ and $\angle r_1 = \angle r_2$	½	3
	SECTION- C		
12.	I (B) II (C) III (D) IV (C) V (C)	1 1 1 1 1	5

* * *

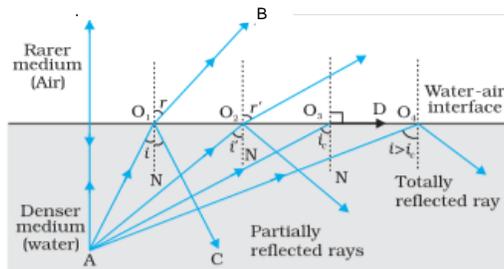Senior **Secondary School** Term II Examination, **2022**

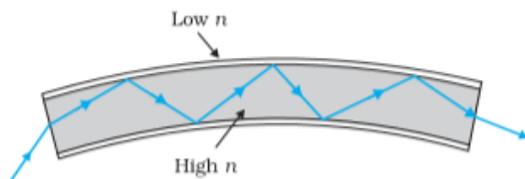**Marking Scheme – PHYSICS (SUBJECT CODE – 042)**

(PAPER CODE – 55/1/2)

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	SECTION - A		
1.	Formation of depletion Region 1 Barrier Potential 1 **Formation of depletion region:** During formation of p-n junction a hole diffuses from p to n region and electron diffuses from n to p region due to concentration gradient. It leaves behind immobile ions at the junction on both sides. This space charge region at the junction is together called depletion region. **Potential Barrier** : The immobile ions on p side are negative and on n side are positive. They create a potential difference preventing the further flow of majority charge carriers. This potential is called as barrier potential.	1 1	2
2.	Energy band diagram ½ + ½ Significance 1 n-type p-type **Significance** n-type semiconductors – small energy gap between donor level and conduction band which can be easily covered by thermally excited electrons. p-type semiconductors - small energy gap between acceptor level and valence band which can be easily covered by thermally excited electrons. **Alternatively** The conductivity of semiconductor is improved with the creation of donor and acceptor levels.	½ + ½ ½ ½	2

3(a).	Graph 1 Conclusions (any two) ½ + ½		

(Give full credit if axis are marked and values are not given)

Conclusions

- Most of the alpha particles pass undeviated through the gold foil.
- A few alpha particles, get deflected through 90° or more.
- Only about 0.14% of the incident alpha particles are reflected by large angle.
- A very few alpha particles retrace their path.
  Any other two conclusions

1

½+½

2

OR

3(b).

i) Same intensity different frequency   1   ii) Same frequency different intensity   1

i)   **ii)**

1+1

2

SECTION- B

4.	Principle of optical fibre 1 Diagram of TIR 1 Use of optical fibre ½ +½		

An optical fibre works on the principle of Total internal reflection.

1

Alternatively

Uses of optical fibres(any two)

i)   Medical and optical examination (endoscopy).
ii)   Transmission and reception of signals
iii) Photometric sensors.

½+½   3

5.		

a) Calculation of work function of metal	1 ½
b) Response to red laser	1 ½

a) $\lambda = 200$ nm , stopping potential = - 2.5V
    K.E. $= 2.5 \times 1.6 \times 10^{-19}$ J $= 4 \times 10^{-19}$ J

$$E = h\nu = h\frac{c}{\lambda}$$ ½

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{200 \times 10^{-9}}$$

$$= 9.945 \times 10^{-19} J$$ ½

Work function = E – eV

$$= (9.945 \times 10^{-19} - 4 \times 10^{-19}) \ J$$

$$= 5.595 \times 10^{-19} \ J$$ ½

b) Wavelength of red light= 6328 $\overset{0}{A}$

$$E = h\nu = h\frac{c}{\lambda}$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{6328 \times 10^{-10}}$$ ½

$$= 0.00314 \times 10^{-16} J$$

$$= 3.14 \times 10^{-19} J$$ ½

Energy of red light < work function of metal surface
∴ No emission of photoelectrons takes place.   ½   3

Alternatively (b)

work function $= h\nu_0 = h\dfrac{c}{\lambda'}$

$$\lambda' = \dfrac{6.63\times10^{-34}\times3\times10^{8}}{5.595\times10^{-19}}$$

$$= 3.55\times10^{-7}\,J$$

$$= 3550A^{0}$$

Wavelength required for emission < wavelength of red light

∴ no emission of photoelectron

6(a).

Calculation of distance of first minimum	1 ½
Calculation of distance of second maximum	1 ½

   (i) $y = \dfrac{\lambda D}{a}$ ½

        $= \dfrac{600\times10^{-9}\times1}{0.2\times10^{-3}}$ ½

        $= 3\times10^{-3}\,m = 3\ mm$ ½

  (ii) $y = (n+\dfrac{1}{2})\dfrac{\lambda D}{a}$ ½

       $y = (2+\dfrac{1}{2})\dfrac{\lambda D}{a}$

       $y = \dfrac{5}{2}\dfrac{\lambda D}{a}$ ½

       $y = \dfrac{5}{2}\times\dfrac{600\times10^{-9}\times1}{0.2\times10^{-3}}$

       $= 7.5\times10^{-3} = 7\cdot5\ mm$ ½   3

OR

6(b).

Finding the ratio of powers	1½
Finding the power of combination and nature	1½

	(i) From $P = (\mu - 1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$	½	

$P_1 = P_{convex} = (\mu - 1)\left(\dfrac{1}{R_1} - (-\dfrac{1}{R_2})\right)$ ½

$= (\mu - 1)(\dfrac{2}{R})$

$P_2 = P_{concave} = (\mu - 1)\left(-\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

$= -(\mu - 1)(\dfrac{2}{R})$

$\therefore \dfrac{P_1}{P_2} = \dfrac{(\mu_1 - 1)}{-(\mu_2 - 1)} = \dfrac{(\mu_1 - 1)}{(1 - \mu_2)}$ ½

(ii) $P = P_1 + P_2$ ½

$= (\mu_1 - 1)\left(\dfrac{2}{R}\right) + (-(\mu_2 - 1))\left(\dfrac{2}{R}\right)$

$P = \dfrac{2(\mu_1 - \mu_2)}{R}$ ½

As $\mu_2 > \mu_1$, P is negative

$\therefore$ Nature is diverging   ½   3

7(a).

i) Reason	1
ii) Identification of radiation	1
Uses	½ + ½

i) Refraction arises through interaction of incident light with the atomic constituents of matter. Atoms may be viewed as oscillators which take up the frequency of the external agency causing forced oscillations. Thus the frequency of refracted light equals the frequency of incident light.   1

Alternatively

Frequency is the characteristic of the source of light. So it remains unaffected. But λ depends on refractive index (μ) of the medium as —

$\lambda_m = \dfrac{\lambda_o}{\mu}$

ii) Infrared/ Microwaves/ Radio waves   1

Uses of Infrared rays (any two)

- Remote control
- Green house effect
- Photography in foggy condition

- To reveal secret writings
- Infrared lamps

Uses of Microwaves (any two)

- Radar System
- Geostationary satellite
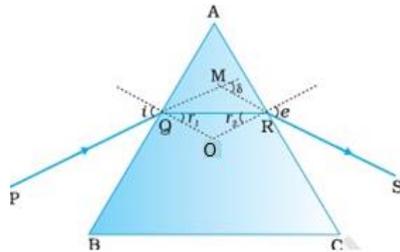- Microwave ovens

Uses of Radiowaves (any two)

- TV transmission
- Radio broadcast
- Mobile transmission

½+½

3

OR

7(b).

i)Diagram	1
Proof of relation $\delta = (i+e) - A$	1 ½
ii)Finding minimum deviation	½

Diagram

1

$\delta = (i - r_1) + (e - r_2)$

½

$\delta = (i + e) - (r_1 + r_2)$

In Quadrilateral AQOR

$\angle Q = \angle R = 90^\circ$ $\therefore \angle A + \angle O = 180^\circ$ ---------(1)

½

In ΔQOR

$O + r_1 + r_2 = 180°$ ---------(2)

Comparing (1) and (2)

$\therefore A = r_1 + r_2$

½

$\therefore \delta = (i + e) - A$

i)   If a ray passes symmetrically through a prism (parallel to base of prism), the value of angle of deviation is minimum.

3

At this angle $\angle i = \angle e$ and $\angle r_1 = \angle r_2$

½

8.			
	Statement of working principle of LED 1 Advantages ½ + ½ Disadvantages ½		

When the diode is forward biased, electrons are sent from n region to p region and holes are sent from p region to n region. At the junction the concentration of minority carriers increases. Thus at the junction, the excess minority carriers recombine with majority carriers and energy is released in the form of photons.   **1**

Advantages (any two):

(i) Low operational voltage

(ii) Less power consumption

(iii) Fast action   **½+½**

(iv) Long life and ruggedness

Disadvantages (any two) :

(i) High cost

(ii) Can get damaged due to overheating   **½+½**

(iii) Excess of voltage or current can damage LED   **3**

(Note: Award last 1 mark, even if disadvantages are not given.)

9.			
	i) Energy level diagram 1 ii) Finding the ratio of wavelength 2		

i)   Hydrogen atom energy level diagram

Total energy, E (eV)

Unbound (ionised) atom

0

−0.85 $n = 5$
    $n = 4$

−1.51 $n = 3$ Excited states

−3.40 $n = 2$

Ground state

−13.6 $n = 1$

     1

ii) $\dfrac{1}{\lambda} = R\left|\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right|$ ½

For longest wavelength in Lyman series

    $n_1 = 1, \; n_2 = 2$

$$\dfrac{1}{\lambda_1} = R\left[\dfrac{1}{1^2} - \dfrac{1}{2^2}\right] = R\left[1 - \dfrac{1}{4}\right] = \dfrac{3}{4}R$$ ½

$$\therefore \lambda_1 = \dfrac{4}{3R}$$

For shortest wavelength in Lyman Series

    $n_1 = 1, \; n_2 = \infty$ ½

$$\dfrac{1}{\lambda_2} = R\left[\dfrac{1}{1^2} - \dfrac{1}{\infty^2}\right] = R[1 - 0] = R$$

$$\therefore \lambda_2 = \dfrac{1}{R}$$

$$\dfrac{\lambda_1}{\lambda_2} = \dfrac{\dfrac{4}{3R}}{\dfrac{1}{R}} = \dfrac{4}{3}$$ ½   3

10.

| Finding two positions of object   3 |

Power of lens = +5 D

Focal length of lens = $\dfrac{100}{5}$ = 20 cm

Magnification ,m = ± 4 ½

Case I ,m = 4 = $\dfrac{v}{u}$ $\therefore v = 4u$ ½

$$\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$$

$$\dfrac{1}{20} = \dfrac{1}{4u} - \dfrac{1}{u}$$

$$u = -15cm$$ 1

Case II, m = - 4 = $\dfrac{v}{u}$ $\therefore v = -4u$ ½

	$\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$			
	$\dfrac{1}{20} = \dfrac{1}{-4u} - \dfrac{1}{u}$ $u = -25cm$		½	3

11.			
	Calculation of mass defect 2 Calculation of energy released 1		
	$^2_1\text{H} + ^3_1\text{H} \rightarrow ^4_2\text{He} + n + Energy$ Mass defect = mass of reactants – mass of products $\Delta m = m(^2_1\text{H} + ^3_1\text{H}) - m(^4_2\text{He} + ^1_0 n)$ Mass defect $= (2 \cdot 014102 + 3 \cdot 016049) - (4 \cdot 002603 + 1 \cdot 008665)$ $= 5 \cdot 030151 - 5 \cdot 011268$ $= 0 \cdot 018883 u$ Energy released $= \Delta m \times 931.5$ MeV $= 0.018883 \times 931.5$ MeV $= 17 \cdot 58$ MeV	½ ½ ½ ½ ½ ½	3

	SECTION- C		

12.			
	I (B)	1	
	II (C)	1	
	III (D)	1	
	IV (C)	1	
	V (C)	1	5

* * *

Strictly Confidential: (For Internal and Restricted use only)
SeniorSecondary School Term II Examination, 2022
Marking Scheme – PHYSICS (SUBJECT CODE – 042)
(PAPER CODE – 55/1/3)

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 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 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, marks should be awarded.**

4. 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. 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.

5. Evaluators will mark(√) wherever answer is correct. For wrong answer 'X' be marked. Evaluators will not put right kind of mark while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**

6. 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.

7. 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.

8. If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out.

9. No marks to be deducted for the cumulative effect of an error. It should be penalized only once.

10. A full scale of marks 0-35 (example 0-40 marks as given in Question Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.

11. Every examiner has to necessarily do evaluation work for full working hours i.e. 8 hours every day and evaluate 30 answer books per day in main subjects and 35answer books per day in other subjects (Details are given in Spot Guidelines).the This is in view of reduced syllabus and number of questions in question paper.

12. 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 a reply.

   • 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.

   • 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.

13. 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.

14. 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.

15. The Examiners should acquaint themselves with the guidelines given in the Guidelines for spot Evaluation before starting the actual evaluation.

16. 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.

17. The Board permits candidates to obtain photocopy of the Answer Book on request in an RTI application and also separately as a part of the re-evaluation process on payment of the processing charges.

Q. No.	EXPECTED ANSWER / VALUE POINTS	Marks	Total Marks

1(a).	Graph 1
	Conclusions (any two) ½ + ½
	
	(Give full credit if axis are marked and values are not given)
	Conclusions
	   • Most of the alpha particles pass undeviated through the gold foil.
	   • A few alpha particles , get deflected through 90° or more.
	   • Only about 0.14% of the incident alpha particles are reflected by large angle.
	   • A very few alpha particles retrace their path.
	    Any other two conclusions
		1
		
		½+½
			2

	OR		
1(b).	i) Same intensity different frequency 1 ii) Same frequency different intensity 1 **i)** **ii)** 	1+1	2

2.			
	Difference between intrinsic and extrinsic semiconductor 1 Reason for Electrical neutrality 1		
	Intrinsic semiconductors are pure semiconductors while extrinsic semiconductors are doped with either trivalent or pentavalent impurities.	1	
	Extrinsic semiconductor maintains an overall charge neutrality as the charge of additional charge carriers is just equal and opposite to that of the ionised cores in the lattice.	1	2

3.			
	Energy band diagram ½ + ½ Significance 1		
	  n-type **p-type**	½ + ½	
	Significance n-type semiconductors – small energy gap between donor level and conduction band which can be easily covered by thermally excited electrons.	½	
	p-type semiconductors - small energy gap between acceptor level and valence band which can be easily covered by thermally excited electrons.	½	
	Alternatively The conductivity of semiconductor is improved with the creation of donor and acceptor levels.		2

4(a).			
	Calculation of distance of first minimum 1 ½ Calculation of distance of second maximum 1 ½		
	(i) $y = \dfrac{\lambda D}{a}$	½	
	$= \dfrac{600 \times 10^{-9} \times 1}{0.2 \times 10^{-3}}$	½	
	$= 3 \times 10^{-3} \, m = 3 \, mm$	½	

(ii) $y = (n + \frac{1}{2}) \frac{\lambda D}{a}$ ½

$y = (2 + \frac{1}{2}) \frac{\lambda D}{a}$

$y = \frac{5}{2} \frac{\lambda D}{a}$ ½

$y = \frac{5}{2} \times \frac{600 \times 10^{-9} \times 1}{0.2 \times 10^{-3}}$ ½ 3

$= 7.5 \times 10^{-3} = 7 \cdot 5$ mm

OR

4(b).

Finding the ratio of powers	1½
Finding the power of combination and nature	1½

(i) From $P = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ½

$P_1 = P_{convex} = (\mu - 1)\left(\frac{1}{R_1} - (-\frac{1}{R_2})\right)$

$= (\mu - 1)(\frac{2}{R})$ ½

$P_2 = P_{concave} = (\mu - 1)\left(-\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= -(\mu - 1)(\frac{2}{R})$

$\therefore \frac{P_1}{P_2} = \frac{(\mu_1 - 1)}{-(\mu_2 - 1)} = \frac{(\mu_1 - 1)}{(1 - \mu_2)}$ ½

(ii) $P = P_1 + P_2$ ½

$= (\mu_1 - 1)\left(\frac{2}{R}\right) + (-(\mu_2 - 1))\left(\frac{2}{R}\right)$

$P = \frac{2(\mu_1 - \mu_2)}{R}$ ½

As $\mu_2 > \mu_1$, P is negative

$\therefore$ Nature is diverging. ½ 3

5.			
	Definition of distance of closest approach 1 ½ Effect on distance of closest approach due to change in K.E. 1 ½		

The minimum distance up to which an alpha particle travel along the central line of the nucleus before it rebounds is called distance of closest approach.

1 ½

Alternatively

An alpha particle travelling directly towards the centre of a nucleus slows down as it approaches the nucleus due to repulsive force. At a distance r_0 from the nucleus, the α- particle stops and its total kinetic energy converts into electrostatic potential energy. This distance r_0 is called distance of closest approach.

$$r_0 = \frac{2Ze^2}{4\pi \in_0 \ K.E.}$$

½

i.e., $r_0 \propto \dfrac{1}{K.E.}$

½

as K is doubled , r_0 is halved.

½

3

(Award full 1½ marks if a student writes r_0 is halved without writing formula)

6.			
	Diagram of reflected wavefront 1 Proof of laws of reflection 2		

1

ΔEAC and ΔBAC are congruent   (RHS congruency)

1

$\therefore \angle i = \angle r$

½

The plane of mirror is $\perp$ to plane of paper hence the incident ray, reflected ray and normal ray lie in same plane.

½

3

7.			
	a) Calculation of speed of electron 1 ½ b) Calculation of Kinetic energy of electron 1 ½		

a) $\lambda = \dfrac{h}{mv}$ ½

$v = \dfrac{h}{m\lambda} = \dfrac{6.63\times10^{-34}}{9.1\times10^{-31}\times0.30\times10^{-9}}$ ½

    $= 2.41\times10^{6} \text{m/s}$ ½

b) $\text{K.E.} = \dfrac{1}{2}mv^2$

    $= \dfrac{1}{2}\times9.1\times10^{-31}\times(2.41\times10^{6})^2 \text{J}$ ½

    $= 26.42\times10^{-19} \text{J}$ ½

    K.E in eV

    $= \dfrac{26.42\times10^{-19}}{1.6\times10^{19}} = 16.5 eV$ ½   3

8.			
	Calculation of mass defect 2 Calculation of energy released 1		

$_1^2\text{H} + _1^3\text{H} \rightarrow _2^4\text{He} + n + Energy$

Mass defect = mass of reactants – mass of products

$\Delta m = m(_1^2\text{H} + _1^3\text{H}) - m(_2^4\text{He} + _0^1 n)$ ½

Mass defect $= (2\cdot014102 + 3\cdot016049) - (4\cdot002603 + 1\cdot008665)$ ½

              $= 5\cdot030151 - 5\cdot011268$ ½

              $= 0\cdot018883 u$ ½

Energy released $= \Delta m \times 931.5$ MeV   ½

            $= 0.018883 \times 931.5$ MeV

            $= 17\cdot58$ MeV   ½   3

9(a).

i) Reason	1
ii) Identification of radiation	1
Uses	½ + ½

i) Refraction arises through interaction of incident light with the atomic constituents of matter. Atoms may be viewed as oscillators which take up the frequency of the external agency causing forced oscillations. Thus the frequency of refracted light equals the frequency of incident light.

Alternatively

Frequency is the characteristic of the source of light. So it remains unaffected. But λ depends on refractive index (μ) of the medium as —

$$\lambda_m = \frac{\lambda_o}{\mu}$$

ii) Infrared/ Microwaves/ Radio waves

Uses of Infrared rays (any two)

- Remote control
- Green house effect
- Photography in foggy condition
- To reveal secret writings
- Infrared lamps

Uses of Microwaves (any two)

- Radar System
- Geostationary satellite
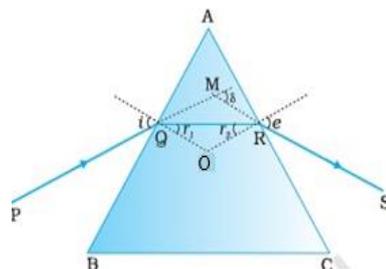- Microwave ovens

Uses of Radiowaves (any two)

- TV transmission
- Radio broadcast
- Mobile transmission

1

1

½+½

3

OR

9(b)

i) Diagram	1
Proof of relation $\delta = (i + e) - A$	1 ½
ii) Finding minimum deviation	½

Diagram

1

	$\delta = (i - r_1) + (e - r_2)$		½	
	$\delta = (i + e) - (r_1 + r_2)$			
	In Quadrilateral AQOR			
	$\angle Q = \angle R = 90^\circ \qquad \therefore \angle A + \angle O = 180^\circ \qquad \text{--------(1)}$			
	In ΔQOR			
	$O + r_1 + r_2 = 180^\circ \qquad \text{--------(2)}$		½	
	Comparing (1) and (2)			
	$\therefore A = r_1 + r_2$		½	
	$\therefore \delta = (i + e) - A$			
	i) If a ray passes symmetrically through a prism (parallel to base of prism), the value of angle of deviation is minimum. At this angle $\angle i = \angle e$ and $\angle r_1 = \angle r_2$		½	3

10.

> Statement of working principle of LED   1
> Advantages   ½ + ½
> Disadvantages   ½ + ½

When the diode is forward biased, electrons are sent from n region to p region and holes are sent from p region to n region. At the junction the concentration of minority carriers increases. Thus at the junction, the excess minority carriers recombine with majority carriers and energy is released in the form of photons.   **1**

Advantages (any two):
 (i) Low operational voltage
 (ii) Less power consumption
(iii) Fast action
(iv) Long life and ruggedness

   ½+½

Disadvantages (any two) :
 (i) High cost
 (ii) Can get damaged due to overheating
(iii) Excess of voltage or current can damage LED

   ½+½   3

(Note: Award last 1 mark, even if disadvantages are not given.)

11.			
	Calculation of Angle of prism 2 Effect of water on prism 1		
	$\mu = \sqrt{3}$, $\qquad\qquad \delta = A$		
	$\mu = \dfrac{\sin \dfrac{(A + \delta_m)}{2}}{\sin(A/2)}$	½	
	$\sqrt{3} = \dfrac{\sin \dfrac{(A + A)}{2}}{\sin(A/2)} = \dfrac{\sin A}{\sin \dfrac{A}{2}}$	½	
	$\sqrt{3} = \dfrac{2\sin \dfrac{A}{2}\cos \dfrac{A}{2}}{\sin \dfrac{A}{2}} = 2\cos \dfrac{A}{2}$	½	
	$\dfrac{\sqrt{3}}{2} = \cos \dfrac{A}{2}$ $\dfrac{A}{2} = 30$	½	
	$\therefore A = 60°$		
	With increase in refractive index of surrounding medium, angle of deviation (δ_m) will decrease	1	3
	SECTION- C		
12.	I (B) II (C) III (D) IV (C) V(C)	1 1 1 1 1	5

* * *