Series : SGN/C

रोल नं.
Roll No. ⬜⬜⬜⬜⬜⬜⬜

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

- कृपया जाँच कर लें कि इस प्रश्न–पत्र में मुद्रित पृष्ठ **16** हैं ।
- प्रश्न–पत्र में दाहिने हाथ की ओर दिए गए कोड नम्बर को छात्र उत्तर–पुस्तिका के मुख–पृष्ठ पर लिखें ।
- कृपया जाँच कर लें कि इस प्रश्न–पत्र में **26** प्रश्न हैं ।
- **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, प्रश्न का क्रमांक अवश्य लिखें ।**
- इस प्रश्न–पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न–पत्र का वितरण पूर्वाह्न में 10.15 बजे किया 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 ।
- Please check that this question paper contains **16** printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **26** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

भौतिक विज्ञान (सैद्धान्तिक)
PHYSICS (Theory)

निर्धारित समय : 3 घंटे
Time allowed : 3 hours

अधिकतम अंक : 70
Maximum Marks : 70

सामान्य निर्देश :

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

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

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

(iv) प्रश्न–पत्र में समग्र पर कोई विकल्प नहीं है । तथापि, **दो** अंकों वाले **एक** प्रश्न में, **तीन** अंकों वाले **एक** प्रश्न में और **पाँच** अंकों वाले **तीनों** प्रश्नों में आन्तरिक चयन प्रदान किया गया है । ऐसे प्रश्नों में आपको दिए गए चयन में से केवल **एक** प्रश्न ही करना है ।

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

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

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

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

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

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

$\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ 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 :

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

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

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

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

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

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

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

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

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

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

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

Mass of electron $(m_e) = 9.1 \times 10^{-31}$ kg

Mass of neutron $= 1.675 \times 10^{-27}$ kg

Mass of proton $= 1.673 \times 10^{-27}$ kg

Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

Boltzmann constant $= 1.38 \times 10^{-23}$ JK^{-1}

खण्ड – अ

SECTION – A

1. किसी इलेक्ट्रॉन को विभवान्तर V तक त्वरित किया गया । यदि यह आरम्भ में विराम में था तो इसके अन्तिम वेग के लिए व्यंजक लिखिए ।

   An electron is accelerated through a potential difference V. Write the expression for its final speed, if it was initially at rest.

2. समान गतिज ऊर्जा के दो प्रोटॉन किसी एकसमान चुम्बकीय क्षेत्र में प्रवेश करते हैं । पहला क्षेत्र के अभिलम्बवत तथा दूसरा क्षेत्र की दिशा से 30° पर प्रवेश करता है । इनके द्वारा चले गए प्रक्षेप पथ के नाम लिखिए ।

   Two protons of equal kinetic energies enter a region of uniform magnetic field. The first proton enters normal to the field direction while the second enters at 30° to the field direction. Name the trajectories followed by them.

3. एकल झिरी द्वारा विवर्तन के लिए फ्रिन्जों का तीव्रता वितरण वक्र खींचिए ।

   Draw a graph showing the intensity distribution of fringes due to diffraction at single slit.

4. व्योम तरंग संचरण के लिए उपयोग होने वाली वैद्युत–चुम्बकीय तरंगों की आवृत्ति परिसर लिखिए ।

   Write the range of frequencies of electromagnetic waves which propagate through sky wave mode.

5. लेंस की क्षमता की परिभाषा दीजिए और इसका SI मात्रक लिखिए ।

   Define the power of a lens. Write its S.I. unit.

खण्ड – ब

SECTION – B

6. तार का कोई आयताकार फ्रेम पृष्ठ के बहिर्गामी अभिलम्बवत दिशिक किसी एकसमान चुम्बकीय क्षेत्र में स्थित है । AB किसी कमानी से जुड़ी है जिसे A′B′ तक खींचकर फिर t = 0 पर मुक्त कर दिया गया है । गुणात्मक रूप से व्याख्या कीजिए कि समय के साथ कुण्डली में प्रेरित emf में किस प्रकार विचरण होगा । (कमानी के दोलनों के मंदन की उपेक्षा कीजिए ।)

A rectangular frame of wire is placed in a uniform magnetic field directed outwards, normal to the paper. AB is connected to a spring which is stretched to A′B′ and then released at time t = 0. Explain qualitatively how induced e.m.f. in the coil would vary with time. (Neglect damping of oscillations of spring)
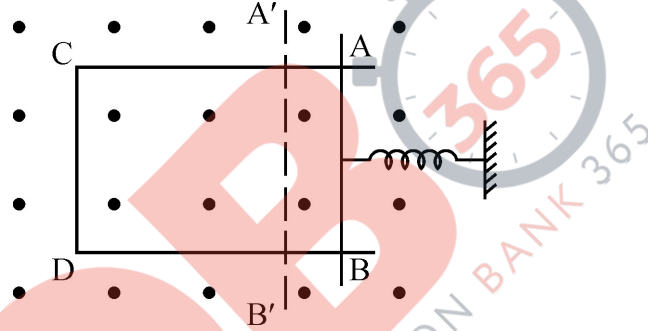
7. (a) पद चुम्बकीय प्रवृत्ति की परिभाषा दीजिए तथा आपेक्षिक चुम्बकशीलता के पदों में इसका संबंध लिखिए ।

   (b) दो चुम्बकीय पदार्थों A और B की आपेक्षिक चुम्बकशीलताएँ 0.96 और 500 हैं । चुम्बकीय पदार्थों A और B को पहचानिए ।

   (a) Define the term magnetic susceptibility and write its relation in terms of relative magnetic permeability.

   (b) Two magnetic materials A and B have relative magnetic permeabilities of 0.96 and 500. Identify the magnetic materials A and B.

8. (a) नाभिकीय विघटनों में प्राप्त विद्युत–चुम्बकीय विकिरणों का एक उपयोग दीजिए ।

   (b) निम्नलिखित स्थितियों की व्याख्या के लिए एक एक उदाहरण दीजिए :

      (i) विस्थापन धारा है, परन्तु कोई चालन धारा नहीं है तथा

      (ii) केवल चालन धारा है, परन्तु कोई विस्थापन धारा नहीं है ।

   (a) Give one use of electromagnetic radiations obtained in nuclear disintegrations.

   (b) Give one example each to illustrate the situation where there is (i) displacement current but no conduction current and (ii) only conduction current but no displacement current.

9. उस प्रकाश की आवृत्ति ज्ञात कीजिए जो किसी धातु के पृष्ठ से इलेक्ट्रॉन उत्सर्जित करती है जिसे 3.3 V के मंदक विभव द्वारा पूर्णतः रोक दिया गया है । यदि 8×10^{14} Hz आवृत्ति पर इस धातु में प्रकाश विद्युत उत्सर्जन आरम्भ हो जाता है, तो इस धातु के लिए कार्य फलन (eV में) परिकलित कीजिए ।

अथवा

किसी लेसर द्वारा 6.0×10^{14} Hz आवृत्ति का एकवर्णी प्रकाश उत्पन्न किया गया है । उत्सर्जन क्षमता 2.0×10^{-3} W है । परिकलन कीजिए (i) प्रकाश किरण पुंज में किसी फोटान की ऊर्जा का (ii) स्रोत द्वारा औसत तौर पर प्रति सेकण्ड उत्सर्जित होने वाले फोटॉनों की संख्या का ।

Find the frequency of light which ejects electrons from a metal surface, fully stopped by a retarding potential of 3.3 V. If photo electric emission begins in this metal at a frequency of 8×10^{14} Hz, calculate the work function (in eV) for this metal.

OR

Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2.0×10^{-3} W. Calculate the (i) energy of a photon in the light beam and (ii) number of photons emitted on an average by the source.

10. किसी हाइड्रोजन परमाणु में (i) द्वितीय अनुमत ऊर्जा स्तर से प्रथम स्तर तथा (ii) उच्चतम अनुमत ऊर्जा स्तर से द्वितीय अनुमत स्तर तक किसी इलेक्ट्रॉन के संक्रमण के कारण उत्सर्जित विकिरणों की आवृत्तियों का अनुपात परिकलित कीजिए ।

Calculate the ratio of the frequencies of the radiation emitted due to transition of the electron in a hydrogen atom from its (i) second permitted energy level to the first level and (ii) highest permitted energy level to the second permitted level.
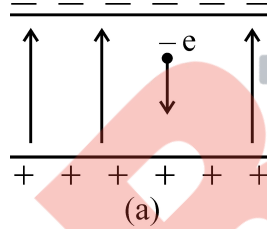
खण्ड – स

SECTION – C

11. विद्युत फ्लक्स की परिभाषा लिखिए तथा इसका SI मात्रक लिखिए । चित्र में दिखाए गए विद्युत क्षेत्र अवयव $E_x = \alpha x$, $E_y = 0$, $E_z = 0$ हैं, जहाँ $\alpha = \frac{100\ N}{Cm}$, घन के भीतर के आवेश का परिकलन कीजिए, a = 0.1m मानिए ।
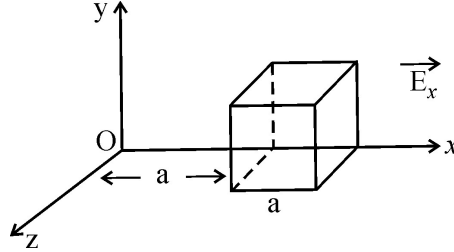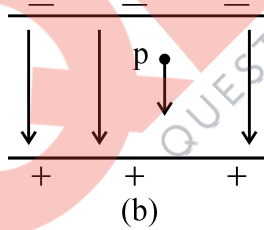

अथवा

एक इलेक्ट्रॉन 2.0×10^4 N/C^{-1} परिमाण के एकसमान विद्युत क्षेत्र में 1.5 cm दूरी तक गिरता है (चित्र (a)) विराम अवस्था से चलकर इस दूरी तक गिरने में इलेक्ट्रॉन द्वारा लिए गए समय का परिकलन कीजिए ।

(a)

क्षेत्र का परिमाण समान रखते हुए यदि इसकी दिशा उत्क्रमित (उल्टी) कर दी जाए (चित्र b) तो एक प्रोटॉन द्वारा इतनी दूरी तक गिरने में लिए गए समय का परिकलन कीजिए ।

(b)

Define electric flux and write its SI unit. The electric field components in the figure shown are : $E_x = \alpha x$, $E_y = 0$, $E_z = 0$ where $\alpha = \frac{100\ N}{Cm}$. Calculate the charge within the cube, assuming a = 0.1m.
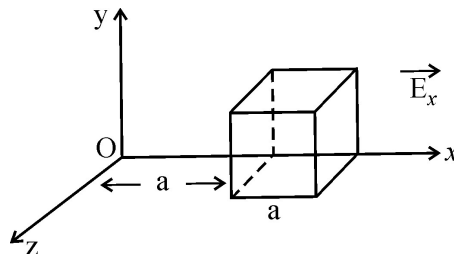
OR

An electron falls through a distance of 1.5 cm in a uniform electric field of magnitude 2.0×10^4 N/C (Fig. a)

(a)
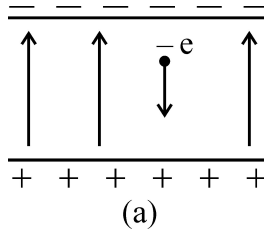
Calculate the time it takes to fall through this distance starting from rest.

(b)
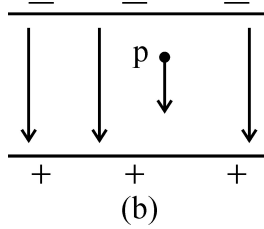
If the direction of the field is reversed (fig. b) keeping its magnitude unchanged, calculate the time taken by a proton to fall through this distance starting from rest.

12. ε_1 और ε_2 emf के दो सेल जिनके आन्तरिक प्रतिरोध क्रमशः r_1 और r_2 हैं, समांतर क्रम में संयोजित हैं –

(i) संयोजन के तुल्य प्रतिरोध, तथा

(ii) संयोजन के तुल्य emf

के लिए व्यंजक प्राप्त कीजिए ।

Two cells of emfs ε_1 & ε_2 and internal resistances r_1 & r_2 respectively are connected in parallel. Obtain expressions for the equivalent.

(i) resistance and

(ii) emf of the combination

13. (a) दो समांतर विद्युत धारावाही चालकों के बीच लगने वाले बल के पदों में विद्युत धारा के SI मात्रक की परिभाषा दीजिए ।

(b) एक दूसरे से पृथकन d के दो लम्बे सीधे समान्तर चालकों से समान दिशा में I_a और I_b स्थिर धाराएँ प्रवाहित हो रही हैं । इन चालकों के बीच आकर्षण की व्याख्या किस प्रकार की जा सकती है ? यदि इन दोनों चालकों के ठीक मध्य में किसी तीसरे चालक को, जिससे धारा I_c विपरीत दिशा में प्रवाहित हो रही है, रख दिया जाए तो तीसरे चालक पर कार्यरत परिणामी बल ज्ञात कीजिए ।

(a) Define SI unit of current in terms of the force between two parallel current carrying conductors.

(b) Two long straight parallel conductors carrying steady currents I_a and I_b along the same direction are separated by a distance d. How does one explain the force of attraction between them ? If a third conductor carrying a current I_c in the opposite direction is placed just in the middle of these conductors, find the resultant force acting on the third conductor.

14. (a) जब I_0 तीव्रता का कोई अध्रुवित प्रकाश किसी पोलरॉयड से गुजरता है, तो रैखिकतः ध्रुवित प्रकाश की तीव्रता क्या होती है ? क्या यह पोलरॉयड के अभिविन्यास पर निर्भर करती है ? अपने उत्तर की व्याख्या कीजिए ।

(b) कोई समतल ध्रुवित प्रकाश पुंज किसी पोलरॉयड से गुजरता है । ग्राफ द्वारा पोलरॉयड के घूर्णन कोण के साथ एक पूरे चक्र में पारगमित प्रकाश की तीव्रता का विचरण दर्शाइए ।

(a) When an unpolarized light of intensity I_0 is passed through a polaroid, what is the intensity of the linearly polarized light ? Does it depend on the orientation of the polaroid ? Explain your answer.

(b) A plane polarized beam of light is passed through a polaroid. Show graphically the variation of the intensity of the transmitted light with angle of rotation of the polaroid in complete one rotation.

15. उपयोग किए गए पदों की व्याख्या करते हुए आइंस्टीन के प्रकाश विद्युत समीकरण का उल्लेख कीजिए ।
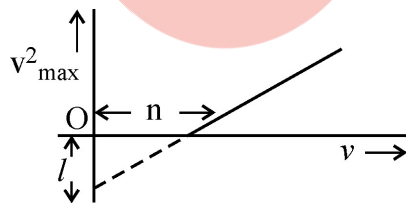
आवृत्ति v का प्रकाश किसी प्रकाश सुग्राही पृष्ठ पर आपतन करता है । इलेक्ट्रॉनों की अधिकतम चाल के वर्ग $\left(v^2_{max}\right)$ और आवृत्ति (v) के बीच ग्राफ आरेख में दर्शाए अनुसार है । प्राचलों l, n तथा इलेक्ट्रॉन का द्रव्यमान m के पदों में आइंस्टीन के प्रकाश विद्युत समीकरण का उपयोग करते हुए (i) प्लांक नियतांक और (ii) प्रकाश सुग्राही पदार्थ के कार्य फलन के लिए व्यंजक प्राप्त कीजिए ।

State Einstein's photoelectric equation explaining the symbols used.
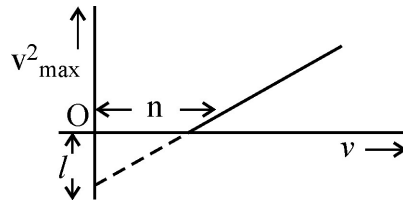
Light of frequency ν incident is on a photosensitive surface. A graph of the square of the maximum speed of the electrons (v^2_{max}) vs. ν is obtained as shown in the figure. Using Einstein's photoelectric equation, obtain expressions for (i) Planck's constant (ii) work function of the given photosensitive material in terms of parameters l, n and mass of the electron m.

16. (a) किसी न्यूक्लिऑनों के युगल की स्थितिज ऊर्जा का, इनके बीच पृथकन के फलन के रूप में, विचरण ग्राफ खींचकर दर्शाइए । उन क्षेत्रों को अंकित कीजिए जहाँ नाभिकीय बल (i) आकर्षी, तथा (ii) प्रतिकर्षी है ।

(b) दी गयी नाभिकीय अभिक्रिया –

$$n + {}^{235}_{92}U \longrightarrow {}^{a}_{54}Xe + {}^{94}_{b}Sr + 2n$$
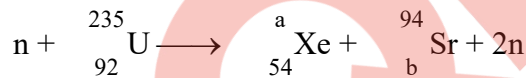
में a और b के मान निर्धारित कीजिए ।

(a) Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions where the nuclear force is (i) attractive and (ii) repulsive.

(b) In the nuclear reaction

$$n + {}^{235}_{92}U \longrightarrow {}^{a}_{54}Xe + {}^{94}_{b}Sr + 2n$$
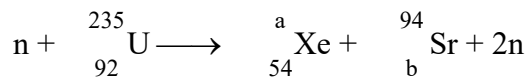
determine the values of a and b.

17. (a) चित्र में दर्शाए गेटों के दिए गए संयोजन के लिए सत्यमान सारणी लिखिए ।
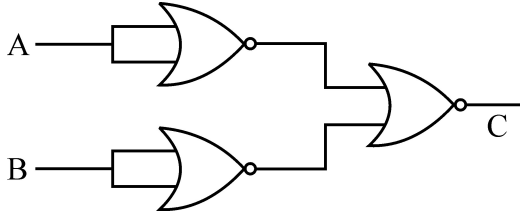
(b) किसी फोटो–डायोड के प्रचालन की संक्षेप में व्याख्या कीजिए ।

(a) Write the truth table for the combination of the gates shown in the figure.
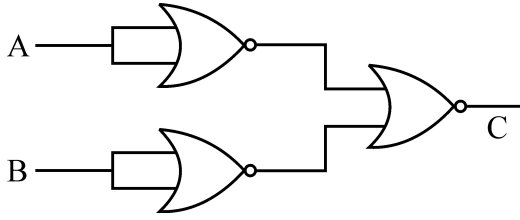
(b) Explain briefly how a photo diode operates.

18. उभयनिष्ठ उत्सर्जक विन्यास में n–p–n जर्मेनियम ट्रांजिस्टर का नामांकित परिपथ आरेख खींचिए । संक्षेप में व्याख्या कीजिए कि यह ट्रांजिस्टर वोल्टता प्रवर्धक के रूप में किस प्रकार उपयोग किया जाता है

Draw a labelled circuit diagram of n-p-n germanium transistor in common emitter configuration. Explain briefly, how this transistor is used as a voltage amplifier.

19. (a) प्रकाश किरण आरेख की सहायता से यह दर्शाइए कि किसी अवतल दर्पण का उपयोग किसी वस्तु के सीधे और आवर्धित बिम्ब को प्राप्त करने में किस प्रकार किया जाता है ।

(b) उपरोक्त किरण आरेख का उपयोग करके दर्पण सूत्र और रैखिक आवर्धन के लिए व्यंजक प्राप्त कीजिए ।

(a) With the help of a ray diagram, show how a concave mirror is used to obtain an erect and magnified image of an object.

(b) Using the above ray diagram, obtain the mirror formula and the expression for linear magnification.

20. (a) बायो सावर्ट नियम का उल्लेख कीजिए और इसे सदिश रूप में व्यक्त कीजिए ।

    (b) बायो सावर्ट नियम का उपयोग करके r त्रिज्या की वृत्तीय कुण्डली, जिससे धारा I प्रवाहित हो रही है के कारण उसके अक्ष पर कुण्डली के केन्द्र से दूरी x पर स्थित किसी बिन्दु पर चुम्बकीय क्षेत्र के लिए व्यंजक प्राप्त कीजिए ।

    (a) State Biot – Savart law and express it in the vector form.

    (b) Using Biot – Savart law, obtain the expression for the magnetic field due to a circular coil of radius r, carrying a current I at a point on its axis distant x from the centre of the coil.

21. किरख़ोफ़ के नियमों का प्रयोग करते हुए दिए गए परिपथ आरेख में B और D के बीच विभवान्तर परिकलित कीजिए ।
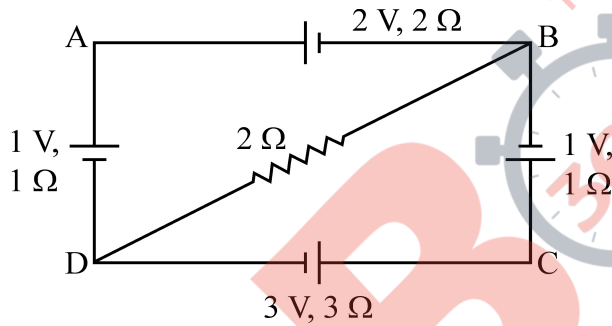
Using Kirchhoff's rules, calculate the potential difference between B and D in the circuit diagram as shown in the figure.
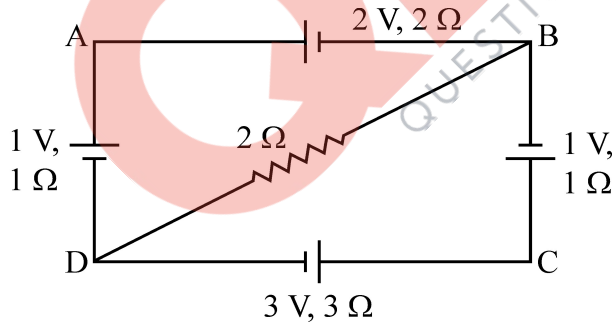
22. (i) व्यतिकरण और विवर्तन से उत्पन्न फ्रिंजों के बीच दो भेद लिखिए ।

    (ii) यंग के किसी द्विझिरी प्रयोग में झिरियों से कुछ दूरी पर स्थित पर्दे पर फ्रिंज प्राप्त होती हैं । यदि पर्दे को झिरियों की ओर 5 cm स्थानान्तरित करें, तो फ्रिंज–चौड़ाई में 30 μm का परिवर्तन हो जाता है । दिया है कि झिरियों के बीच की दूरी 1 mm है । उपयोग किए गए प्रकाश की तरंगदैर्ध्य परिकलित कीजिए ।

(i) Write two points to distinguish between interference and diffraction fringes.

(ii) In a Young's double slit experiment, fringes are obtained on a screen placed a certain distance away from the slits. If the screen is moved by 5 cm towards the slits, the fringe width changes by 30 μm. Given that the slits are 1 mm apart, calculate the wavelength of the light used.

<div align="center">

खण्ड – द

SECTION – D

</div>

23. श्रीमती राजलक्ष्मी अचानक गिरीं और उसके पश्चात वह सीधी खड़ी होने योग्य नहीं थीं । उन्हें अत्यधिक पीड़ा हो रही थी । उनकी पुत्री रीटा उन्हें डॉक्टर के पास ले गयी । डॉक्टर ने श्रीमती राजलक्ष्मी की हड्डियों का फोटोग्राफ लिया और पाया कि हड्डी टूट गयी है । उन्होंने विश्राम करने आवश्यक उपचार लेने का परामर्श दिया ।

(a) हड्डियों का फोटोग्राफ लेने में उपयोग होने वाले विद्युत–चुम्बकीय विकिरणों का नाम लिखिए ।

(b) ये विकिरण किस प्रकार उत्पन्न किए जाते हैं ?

(c) उपयोग किए जाने वाले विद्युत–चुम्बकीय विकिरणों की तरंगदैर्ध्य का परास लिखिए ।

(d) रीटा द्वारा प्रदर्शित दो मूल्य लिखिए ।

Mrs. Rajlakshmi had a sudden fall and was thereafter unable to stand straight. She was in great pain. Her daughter Rita took her to the doctor. The doctor took a photograph of Mrs. Rajlakshmi's bones and found that she had suffered a fracture. He advised her to rest and take the required treatment.

(a) Name the electromagnetic radiation used to take the photograph of the bones.

(b) How is this radiation produced ?

(c) Mention the range of the wavelength of this electromagnetic radiation.

(d) Write two values displayed by Rita.

खण्ड – य

SECTION – E

24. दो बिन्दु आवेश q और – q क्रमशः (0, 0, –a) और (0, 0, a) बिन्दुओं पर स्थित हैं ।

(a) (0, 0, z) और (x, y, 0) पर स्थिर विद्युत विभव परिकलित कीजिए ।

(b) किसी लघु परीक्षण आवेश को X-अक्ष के अनुदिश (5, 0, 0) से (–7, 0, 0) तक ले जाने में कितना कार्य किया जाता है ?

(c) उस स्थिति में आप अपने उत्तर में क्या परिवर्तन करेंगे यदि परीक्षण आवेश का, उन्हीं दो बिन्दुओं के बीच का पथ, X-अक्ष के अनुदिश न होकर कोई अन्य यादृच्छिक पथ हो ?

(d) अब यदि उपरोक्त बिन्दु आवेशों को किसी एकसमान बाह्य विद्युत क्षेत्र $\vec{E}$ में उन्हीं स्थितियों में रखा जाए, तो इस आवेश निकाय की इसके अस्थायी संतुलन के विन्यास में स्थितिज ऊर्जा क्या होगी ?

प्रत्येक प्रकरण में अपने उत्तर की पुष्टि कीजिए ।

अथवा

C_1 धारिता के किसी संधारित्र को विभव V_1 तक जबकि C_2 धारिता के अन्य संधारित्र को विभवान्तर V_2 तक आवेशित किया गया है । अब इन संधारित्रों उनकी अपनी–अपनी आवेशन बैटरियों से वियोजित करके इन्हें एक–दूसरे से समांतर में संयोजित किया गया है । ज्ञात कीजिए ।

(a) एक–दूसरे से संयोजित करने से पूर्व इन दोनों संधारित्रों में संचित कुल ऊर्जा

(b) इन दोनों संधारित्रों के समांतर संयोजन में संचित कुल ऊर्जा

(c) समांतर संयोजन में संचित कुल ऊर्जा और संयोजित करने से पूर्व उनमें कुल संचित ऊर्जा के बीच अन्तर की व्याख्या कीजिए ।

Two point charges q and –q are located at points (0, 0, –a) and (0, 0, a) respectively.

(a) Find the electrostatic potential at (0, 0, z) and (x, y, 0)

(b) How much work is done in moving a small test charge from the point (5, 0, 0) to (–7, 0, 0) along the x-axis ?

(c) How would your answer change if the path of the test charge between the same points is not along the x-axis but along any other random path ?

(d) If the above point charges are now placed in the same positions in a uniform external electric field $\vec{E}$, what would be the potential energy of the charge system in its orientation of unstable equilibrium ?

Justify your answer in each case.

OR

A capacitor of capacitance C_1 is charged to a potential V_1 while another capacitor of capacitance C_2 is charged to a potential difference V_2. The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other.

(a) Find the total energy stored in the two capacitors before they are connected.

(b) Find the total energy stored in the parallel combination of the two capacitors.

(c) Explain the reason for the difference of energy in parallel combination in comparison to the total energy before they are connected.

25. (a) अनुप्रयुक्त A-C स्रोत की आवृत्ति के साथ प्रेरित प्रतिघात तथा धारिता प्रतिघात का विचरण दर्शाने के लिए ग्राफ खींचिए ।

(b) एक AC स्रोत से जुड़े किसी RC श्रेणी परिपथ का फेज़र आरेख खींचिए ।

(c) जब किसी युक्ति X के सिरों पर 220 V प्रत्यावर्ती वोल्टता अनुप्रयुक्त की जाती है तो उससे 0.25A धारा प्रवाहित होती है, जो कला में अनुप्रयुक्त वोल्टता से $\frac{\pi}{2}$ रेडियन पश्च होती है । जब इसी वोल्टता को किसी अन्य युक्ति Y के सिरों पर अनुप्रयुक्त किया जाता है, तो समान धारा प्रवाहित होती है परन्तु अब यह अनुप्रयुक्त वोल्टता की ही कला में होती है ।

(i) युक्तियों X और Y के नाम लिखिए ।

(ii) उस स्थिति में परिपथ में प्रवाहित धारा परिकलित कीजिए जब इसी वोल्टता को X तथा Y के श्रेणी संयोजन पर अनुप्रयुक्त किया जाता है ।

अथवा

(a) किसी ट्रान्सफॉर्मर का कार्यकारी सिद्धान्त लिखिए ।

(b) किसी ट्रान्सफॉर्मर की दक्षता की परिभाषा लिखिए ।

(c) किन्हीं दो कारकों का उल्लेख कीजिए जो किसी ट्रान्सफॉर्मर की दक्षता कम कर देते हैं ।

(d) यदि निर्गत प्रतिरोध 440 Ω है, तो 220 V को 22 V में परिवर्तित करने वाले 90% दक्षता के अपचायी ट्रान्सफॉर्मर की प्राथमिक कुण्डली में प्रवाहित धारा परिकलित कीजिए ।

(a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of the applied ac source.

(b) Draw the phasor diagram for a series RC circuit connected to an ac source.

(c) An alternating voltage of 220 V is applied across a device X, a current of 0.25 A flows, which lag behind the applied voltage in phase by $\frac{\pi}{2}$ radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.

   (i)   Name the devices X and Y.

   (ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y.

OR

(a) State the principle of working of a transformer.

(b) Define efficiency of a transformer.

(c) State any two factors that reduce the efficiency of a transformer.

(d) Calculate the current drawn by the primary of a 90% efficient transformer which steps down 220 V to 22 V, if the output resistance is 440 Ω.

26. (a) उपयुक्त चित्र की सहायता से p-n संधि डायोड के निर्माण में होने वाली दो महत्त्वपूर्ण परिक्रियाओं की व्याख्या कीजिए । अतः (i) ह्रासी क्षेत्र तथा (ii) रोधिका विभव की परिभाषा लिखिए ।

  (b) एक अग्रदिशिक बायस में p-n संधि डायोड का परिपथ चित्र बनाइए और उसकी कार्यविधि की व्याख्या कीजिए ।

अथवा

(a) उन तीन कारकों की संक्षेप में व्याख्या कीजिए । जो श्रव्य आवृत्ति सिग्नल को लम्बे परास की दूरी पर प्रेषित करने में मॉडुलन की आवश्यकता को न्यायसंगत ठहराते हैं ।

(b) निम्नलिखित के तरंगरूप खींचिए : (i) वाहक तरंग (ii) मॉडुलक सिग्नल तथा (iii) आयाम मॉडुलन तरंग
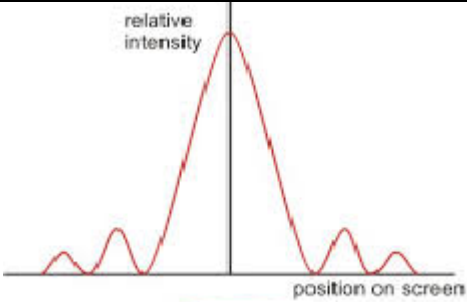
(a) Explain with the help of suitable diagram, the two processes which occur during the formations of a p-n junction diode. Hence define the terms (i) depletion region and (ii) potential barrier.

(b) Draw a circuit diagram of a p-n junction diode under forward bias and explain its working.

OR

(a) Describe briefly three factors which justify the need for modulation of audio frequency signals over long distances in communication.

(b) Draw the waveforms of (i) carrier wave, (ii) a modulating signal and (iii) amplitude modulated wave.

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Senior School Certificate Examination
Marking Scheme - Physics (C) (Code 55/1, Code 55/2, Code 55/3)
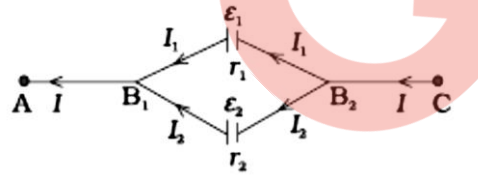
1. The marking scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggested answers. The content is thus indicated. If a student has given any other answer, which is different from the one given in the marking scheme, but conveys the meaning correctly, such answers should be given full weightage.

2. In value-based questions, any other individual response with suitable justification should also be accepted even if there is no reference to the text.

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 adhered to and religiously followed.

4. If a question has parts, please award in the right-hand side for each part. Marks awarded for different part of the question should then be totaled up and written in the left-hand margin and circled.

5. If a question does not have any parts, marks are to be awarded in the left-hand margin only.

6. If a candidate has attempted an extra question, marks obtained in the question attempted first should be retained and the other answer should be scored out.

7. No marks are to be deducted for the cumulative effect of an error. The student should be penalized only once.

8. Deduct ½ mark for writing wrong units, missing units, in the final answer to numerical problems.

9. Formula can be taken as implied from the calculations even if not explicitly written.

10. In short answer type question, asking for two features / characteristics / properties if a candidate writes three features, characteristics / properties or more, only the correct two should be evaluated.

11. Full marks should be awarded to a candidate if his / her answer in a numerical problem is close to the value given in the scheme.

12. In compliance to the judgement of the Hon'ble Supreme Court of India, Board has decided to provide photocopy of the answer book(s) to the candidates who will apply for it along with the requisite fee. Therefore, it is all the more important that the evaluation is done strictly as per the value points given in the marking scheme so that the Board could be in a position to defend the evaluation at any forum.

13. The Examiner shall also have to certify in the answer book that they have evaluated the answer book strictly in accordance with the value points given in the marking scheme and correct set of question paper.

14. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title paper, correctly totaled and written in figures and words.

15. In the past it has been observed that the following are the common types of errors committed by the Examiners

    - Leaving answer or part thereof unassessed in an answer script.
    - Giving more marks for an answer than assigned to it or deviation from the marking scheme.
    - Wrong transference 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 transference to marks from the answer book to award list.
    - Answer marked as correct (√) but marks not awarded.
    - Half or part of answer marked correct (√) and the rest as wrong (×) but no marks awarded.

16. 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

MARKING SCHEME(COMPARTMENT) 2018

SET 55/1   SET 1

Q.NO.	VALUE POINTS/ EXPECTED ANSWERS	MARKS	TOTAL MARKS
	SECTION A		
Q1.	$v = \sqrt{\dfrac{2eV}{m}}$	1	1
Q2.	Normal : Circular	½	
	At an angle of 30^0 it will follow helical path	½	1
Q3.		1	1
Q4.	From few MHz to 30-40 MHz	1	1
Q5.	The power of a lens equals to the reciprocal of its focal length(in meter). Also accept	½	
	$p = \dfrac{1}{f(meter)}$ Do not deduct mark if student does not write the word meter.	½	
	(Alternatively Power of a lens is the ability of conversion /diversion of the rays incident on the lens.)		
	SI Unit: Dioptre(D)		1
	SECTION B		
Q6.	SHM nature of oscillation of the wire AB ½ Expression for instantaneous magnetic flux ½ Expression for instantaneous induced emf ½ Qualitative explanation ½		
	The wire AB would oscillate in a simple harmonic way We can write $x = -a \cos \omega t$ $(as\ x = -a\ at\ t = 0)$ Therefore Instantaneous magnetic Flux $\phi(t) = Blx \qquad (l = AB)$	½ ½	

	Instantaneous induced emf $e(t) = -\dfrac{d\phi}{dt} = aBl\omega \ \sin \omega t$ The induced emf, therefore varies with time sinusoidally. (Alternatively Arm AB executes SHM under the influence of restoring force developed in the spring, consequently an induced emfis produced across the ends of moving armAB which varies sinusoidally.) (Give full credit for the above part if the student explains qualitatively without using mathematical equations)	½ ½	2

Q7.	(a)Definition ½
	    Relation ½
	(b) Identification of A and B ½+ ½
	
	(a) Measure of the response of magnetic material to an external magnetic field. Also accept
	
	$\chi = \dfrac{\lvert M \rvert}{\lvert H \rvert}$
	
	We have
	$\chi = \left(\mu_r - 1\right)$
	(b) 0.96 : Diamagnetic
	     500 : Ferromagnetic
		½
		
		½
		½
		½
			2

Q8.	(a) One use 1 (b) One example each ½+ ½ (a) used to destroy cancer cells (b) (i)The region, between the plates of a capacitor, connected to time varying voltage source,has a displacement current but no conduction current. (ii) The wires, connected to the plates of a capacitor, joined to a time varying or steady voltage source, carry a conduction current but no displacement current. (Alternatively A circuit, having no capacitor in it, and carrying a current has conduction current but no displacement current.)	1 ½ ½	2

Q9.	Finding the Work function 1		
	Finding the Frequency of incident light 1		

We have

$W = h\nu_0$

$= 6.63 \times 10^{-34} \times 8 \times 10^{14} \; J$ ½

$= \dfrac{6.63 \times 10^{-20} \times 8}{1.6 \times 10^{-19}}$

$= 3.315 \; eV$ ½

We have   ½

$h\nu = W + eV_s$

$= (3.315 + 3.3)eV$

$\therefore \nu = \dfrac{6.615 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}} \; Hz$ ½

$= 1.596 \times 10^{15} \; Hz$ 2

OR

	Calculating		
	(i)	Energy of a photon	½ + ½
	(ii)	Number of photons emitted	½ + ½

Energy of photon $= h\nu$ ½

$= 6.63 \times 10^{-34} \times 6.0 \times 10^{14} \; J$

$= 3.978 \times 10^{-19} \; J$

$\cong 2.49 \, eV$ ½

Number of photons emitted per second $= \dfrac{power}{energy \; of \; photon}$ ½

$= \dfrac{2.0 \times 10^{-3} \; J/s}{3.978 \times 10^{-19} \; J}$

$= 5.03 \times 10^{15} \; photons/\sec ond$ ½

2

Q10.		Formula	½		
	(i)	Frequency of first case	½		
	(ii)	Frequency of second case	½		
		Ratio	½		

We have

$$h\nu = E_f - E_i$$

$$= \frac{E_0}{n_f^2} - \frac{E_0}{n_i^2}$$

½

$$(i)\ h\nu_1 = E_0\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = E_0 \times \frac{3}{4}$$

½

$$(ii)\ h\nu_2 = E_0\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = E_0 \times \frac{1}{4}$$

½

$$\therefore \frac{\nu_1}{\nu_2} = 3$$

½   2

SECTION C

Q11.	Definition of Electric flux	1
	SI unit	½
	Formula (Gauss's Law)	½
	Calculation of Charge within the cube	1

Electric Flux is the dot product of electric field and area vector.   1
Also Accept

$$\varphi = \oint \vec{E}.\vec{ds}$$

SI Unit : Nm^2/C or volt -meter   ½

For a given case

$$\phi = \phi_1 + \phi_2 = \left[E_x(at\ x = 2a) - E_x\left(at\ x = a\right) \right]a^2$$

$$= \left[\alpha(2a) - \alpha(a) \right]a^2$$

$$= \alpha a^3$$

$$= 100 \times (0.1)^3 = 0.1\,Nm^2/C$$ ½

But

$$\phi = \frac{q}{\varepsilon_0}$$ ½

$$\therefore q = \varepsilon_0\phi = 8.854 \times 10^{-12} \times 10^{-1} C$$

$$= 0.8854\,pC$$ ½

OR

Relevant formulae	1
Calculation of time taken by the electron	1
Calculation of time taken by the proton	1

	We have Force $=qE$ Acceleration $\quad a = \dfrac{qE}{m}$ Also $s = \dfrac{1}{2}at^2 \quad as\, u = 0$ $\therefore t = \sqrt{\dfrac{2s}{a}}$ $\quad$ (i) $\quad$ For the electron $\quad a = \dfrac{eE}{m}$ $\quad \therefore t = \sqrt{\dfrac{3\times10^{-2} \times 9.1\times10^{-31}}{1.6\times10^{-19} \times 2.0\times10^{4}}}$ $\quad = 2.92\,ns$ $\quad$ (ii) $\quad$ for proton $t = \sqrt{\dfrac{2\times1.5\times10^{-2} \times 1.67\times10^{-27}}{1.6\times10^{-19} \times 2\times10^{4}}}$ $= 0.125\,\mu s$	½ ½ ½ ½ ½ ½	3
12.	<table><tr><td>Obtaining Expression for the equivalent</td><td></td></tr><tr><td>(i) resistance</td><td>1</td></tr><tr><td>(ii) emf</td><td>2</td></tr></table> $\dfrac{1}{r} = \dfrac{1}{r_1} + \dfrac{1}{r_2}$ $\therefore r = \dfrac{r_1 r_2}{r_1 + r_2}$ $I = I_1 + I_2$ $V = E_1 - I_1 r_1 \quad and \quad V = E_2 - I_2 r_2$ $\therefore I = \left(\dfrac{E_1 - V}{r_1}\right) + \left(\dfrac{E_2 - V}{r_2}\right)$ $V = \left(\dfrac{E_1 r_2 + E_2 r_2}{r_1 + r_2}\right) - I\left(\dfrac{r_1 r_2}{r_1 + r_2}\right)$ $also \; V = E_{eq} - I r_{eq}$ $\Longrightarrow \dfrac{E_{eq}}{r_{eq}} = \dfrac{E_1}{r_1} + \dfrac{E_2}{r_2}$	½ ½ ½ ½ ½ ½	3

Q13.		
	(a) Definition of SI unit Of current 1 (b) Explanation of the force of attraction ½ Finding the resultant force acting on the third conductor 1½	

(a) The *ampere* is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} newton per metre of length. **1**

(b) The wire (b) experiences a force due to the magnetic field caused by the current flowing in wire (a).
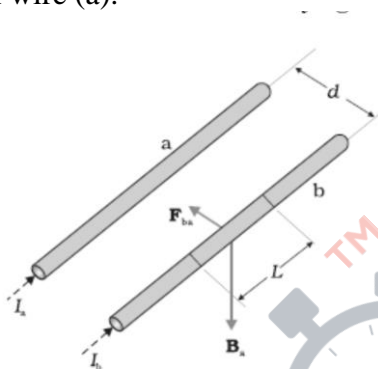
The magnetic field at any point on the wire (b) due to the current in wire (a) is is perpendicular to the plane of two wires and pointing inwards and hence force on it will be towards wire (a). Similarly force on wire (a) will be towards wire (b). Hence two wires carrying currents in same direction attract each other. **½**

Force on wire (3) due to wire (1)

$$= \frac{\mu_0 I_a I_c}{2\pi\left(\dfrac{d}{2}\right)} \text{ towards right}$$ **½**

Force on wire 3 due to wire 2

$$\left(\frac{\mu_0 I_b I_c}{2\pi\left(\dfrac{d}{2}\right)}\right) \text{ towards left}$$ **½**

Net force on wire 3

$$= \frac{\mu_0 I_c}{\pi d}\left[I_a - I_b\right] \text{ towards right}$$ **½**

Also accept

$$= \frac{\mu_0 I_c}{\pi d}\left[I_b - I_a\right] \text{ towards left}$$

Note: please do not deduct last 1/2 mark if the student does not write the direction of force.

3
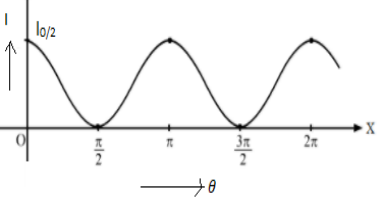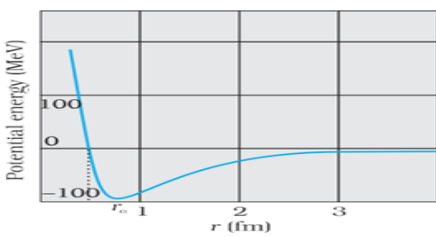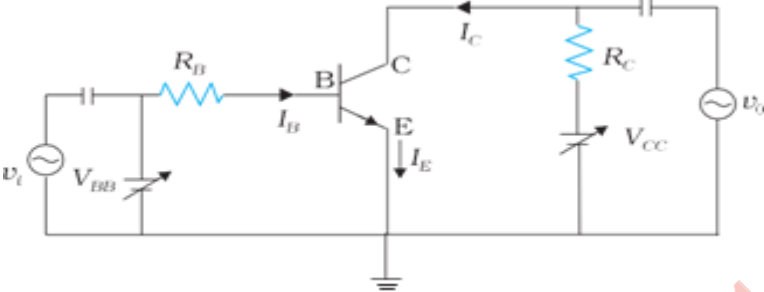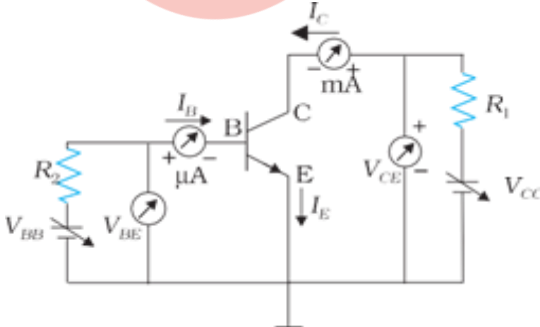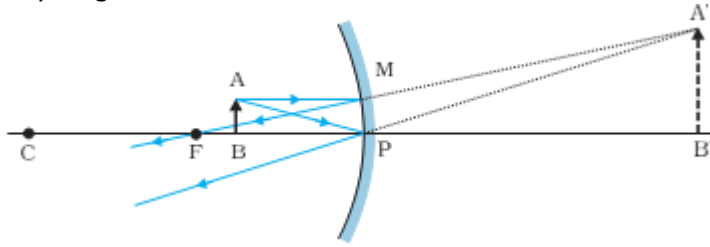
14	a) Intensity of linearly polarized light – ½ Dependence on orientation – ½ Explanation - 1 b) Graphical representation - 1		
	a) The intensity of the linearly polarized light would be $I_0/2$. No; it does not depend on the orientation. Explanation : The polaroid will let the component of the unpolarized light, parallel to its pass axis, to pass through it irrespective of its orientation. b) We have $I = I_0 cos^2\theta$ ∴ The graph is as shown below 	½ ½ 1 1	½ 1 1 3
15	Statement of equation with explanation of symbols – 1 Expression for i. Planck's constant - 1 ii. Work function - 1		
	Einstein's photoelectric equation is $hv = hv_0 (= W) + \frac{1}{2} mv_{max}^2$ $v = frequency\ of\ incident\ light$ $v_0 = threshold\ frequency\ of\ photo\ sensitive\ material$ $W = work\ function$ $\frac{1}{2} mv_{max}^2 = max.\ kinetic\ energy\ of\ the\ emitted\ photoelectrons$ (Also accept if the student writes $$hv = W + eV_s$$ W = work function of photosensitive material V_s = Stopping Potential) From Einstein's photoelectric equation, we have $$hv = W + \frac{1}{2} mv_{max}^2$$ $$\therefore v_{max}^2 = \frac{2}{m} (hv - W)$$ $$= \left(\frac{2h}{m}\right)v + \left(\frac{-2W}{m}\right)$$	½ ½	

	Slope of the given graph = $\frac{l}{n}$ Intercept on the y – axis = $-l$ $\therefore \frac{2h}{m} = \frac{\ell}{n}$ or $h = \frac{m\ell}{2n}$ and - $\ell = \frac{-2\mathcal{W}}{m}$ or $\mathcal{W} = \frac{m\ell}{2}$	½ ½ ½ ½	3

16	a) Drawing the plot — 1 Marking the relevant regions - ½ + ½ b) Finding values of a and b — ½+ ½		
	a) 	1	
	For r > r_0, the force is attractive	½	
	For r < r_0, the force is repulsive	½	
	a) We have, 1 + 235 = a + 94 + 2 X 1 ∴ a = 236 − 96 = 140	½	
	Also 0 + 92 = 54 + b + 2 X 0 ∴ b = 92 − 54 = 38	½	3

17	a) Writing the truth table — 1 b) Photodiode and its operation – 1 + 1		
	a) The inputs of the third gate are $\overline{A}$ and $\overline{B}$. Hence the truth table is as given below.	1	

A	B	$\overline{A}$	$\overline{B}$	C
0	0	1	1	0
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

	(Note: The student need not write the columns for $\overline{A}$ and $\overline{B}$ in her/ his answer) (b) A photodiode is a special purpose $p - n$ junction diode fabricated with a transparent window to allow light to fall on the diode.	½	
	Incident light, with photon energy greater than the energy gap of the semi-conductor, generates electron -hole pairs. The magnitude of the photo current depends on the intensity of intensity of incident light.	½	

	The photodiode is usually operated under reverse bias conditions.	½	
	This is because this makes it easier to detect changes in light intensity and makes the photodiode work as a detector of optical signals.	½	3
18	Labelled circuit diagram – 1 Working as a voltage amplifier - 2		
		1	
	Working as a voltage amplifier:		
	When a small sinusoidal voltage (with amplitude v_s) is connected in series with the dc bias voltage supply, V_{BB}, the base current will have sinusoidal variations super imposed on the value of I_B.	½	
	As a result, the collector current will also have sinusoidal variations super imposed on the value of I_c.	½	
	This results in corresponding sinusoidal variations in the value of the output voltage V_o.	½	
	These sinusoidal variations in output voltage are an amplified version of the corresponding variations in the input voltage. This implies that the transistor can be used as a voltage amplifier.	½	
	(Note : Give 1 mark to those students also who only draw either this circuit diagram or the circuit diagram given below: 		3

19	a) Ray diagram – 1
	 b) Obtaining
	    i. mirror formula – 1 ½
	    ii. expression for liner magnification – ½		

a) Ray Diagram

From similar triangles $A'B'F$ and MPF, we have

$\frac{B'A'}{PM} = \frac{B'F}{FP}$ or $\frac{B'A'}{BA} = \frac{B'F}{FP}$ (since PM = BA)

From similar triangles $A'B'P$ and ABP, we have

$$\frac{B'A'}{BA} = \frac{B'P}{BP}$$

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

Now $B'F = B'P + PF = (+\mathcal{V}) + (-f)$
$$= v - f$$
$$BP = -u$$

$\therefore \frac{v - f}{-f} = \frac{+v}{-u}$

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

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

This is the mirror formula.

Linear magnification = $\frac{B'A'}{BA}$

From similar triangles $A'B'P$ and ABP, we get
$$\frac{B'A'}{BA} = \frac{B'P}{BP}$$

$\therefore$ Linear magnification

$$\frac{B'P}{BP} = \frac{+v}{-u} = -\frac{v}{u}$$
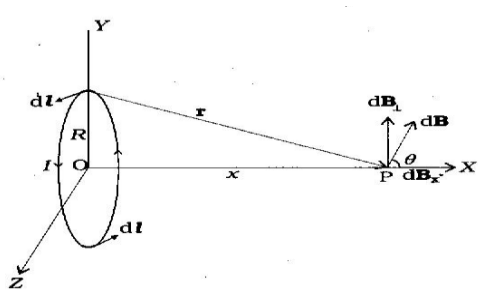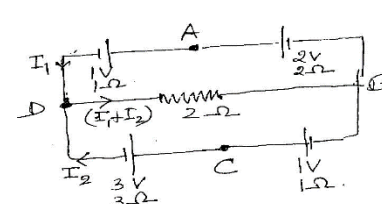
			1	
			½	
			½	
			½	
			½	3
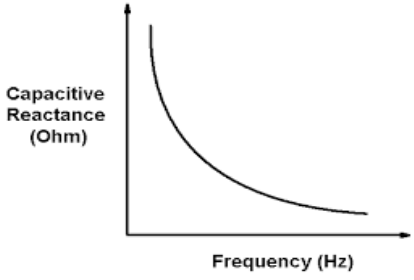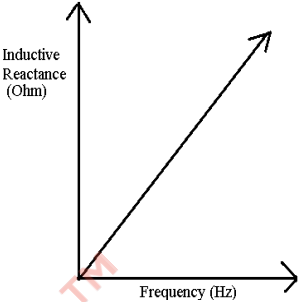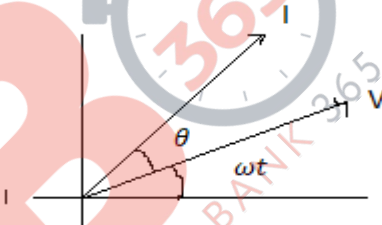
20.	(a) Statement of Biot-Savart law ½ Mark			
	Its vector form ½ Mark			
	(b) Obtaining the required expression 2 Mark			

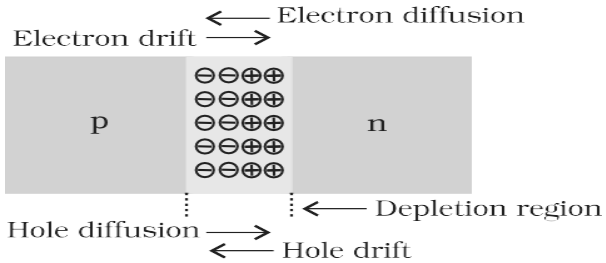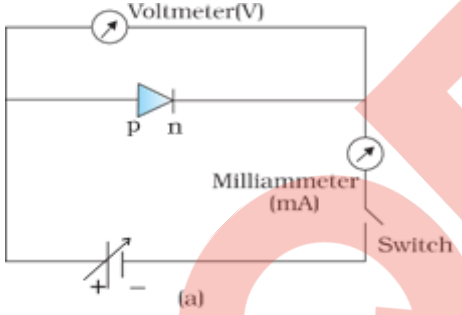|			
	(a) According to Biot Savart law : The magnitude of magnetic field $d\vec{B}$, due to a current element $d\vec{l}$, is (i) proportional to current I and element length, dl (ii) inversely proportional to the square of the distance r. Its direction is perpendicular to the plane containing $d\vec{l}$ and $\vec{r}$. In vector notation,	½	
	$$\overrightarrow{dB} = \frac{\mu_0}{4\pi} I \frac{d\vec{l} \times \vec{r}}{r^3}$$	½	
	(b)		
		½	
	We have $\overrightarrow{dB} = \frac{\mu_0}{4\pi} I \frac{\left| d\vec{l} \times \vec{r} \right|}{r^3}$ $r^2 = x^2 + R^2$		
	$$\therefore \quad dB = \frac{\mu_0 I}{4\pi} \frac{dl}{(x^2 + R^2)^{3/2}}$$ We need to add only the components of $d\vec{B}$ along the axis of the coil. Hence, B $= \int \frac{\mu_0}{4\pi} \frac{I dl}{(x^2 + R^2)^{3/2}} \cos\theta$.	½	
	$$= \int \frac{\mu_0}{4\pi} \frac{(I\, dl)\, R}{(x^2 + R^2)^{3/2}} \cdot$$	½	
	$$= \frac{\mu_0\, I R^2}{2(x^2 + R^2)^{3/2}} \cdot$$	½	
	$$\therefore \quad B = \frac{\mu_0\, I R^2}{2(x^2 + R^2)^{3/2}} \hat{i}$$	½	3
21.	Writing the two loop equations $\quad$ ½ + ½ Mark Finding the current through DB $\quad$ 1½ Marks Finding the p.d. between B and D $\quad$ ½ Mark		
	Using Kirchoff's voltage rule, we have : For loop DABD $I_1 \times 1 + (1) + (-2) + 2I_1 + 2(I_1 + I_2) = 0$ Or $\quad 5I_1 + 2I_2 = 1 \quad$ ...... (i) For loop DCBD $+ I_2 \times 3 + (3) + (-1) + I_2 + 2(I_1 + I_2) = 0$ Or $2I_1 + 6I_2 = -2 \quad$ ....(ii)	½ ½	

		Solving (i) and (ii), we get		
		$I_1 = \frac{5}{13}$ A	½	
		$I_2 = \frac{-6}{13}$ A	½	
		$\therefore$ Current through DB $= I_1 + I_2 = \frac{-1}{13}$ A	½	
		$\therefore$ P.D. between B and D = 0.154 V	½	
				3
22.		(a) Two points of difference ½ + ½ Mark (b) Formula ½ Marks Calculation of wavelength 1½ Mark		
		(a) **Any two point of difference :**		

Interference	Diffraction
Fringes are equally spaced.	Fringes are not equally spaced.
Intensity is same for all maxima	Intensity falls as we go to successive maxima away from the centre.
Superposition of two waves originating from two narrow slits.	Superposition of a continuous family of waves originating from each point on a single slit.
Maxima along an angle λ/a for two narrow slits separated by a distance a.	Minima at an angle of λ/a for a single slit of width a.

½ + ½

(b)
Let D be the distnce of the screen from the plane of the slits.
We have
Fring width $\beta = \dfrac{\lambda D}{d}$

½

In the first case
$\beta = \dfrac{\lambda D}{d}$ or $\beta d = \lambda D$ .... (i)

½

In the second case
$(\beta - 30 \times 10^{-6}) = \dfrac{\lambda(D - 0.05)}{d}$ or $(\beta - 30 \times 10^{-6})d = \lambda(D - 0.05)$ .... (ii)

½

Subtracting (ii) from (i) we get

$30 \times 10^{-6} \times d = \lambda \times 0.05$

$\therefore \lambda = \dfrac{30 \times 10^{-6} \times 10^{-3}}{5 \times 10^{-2}}$ m

$\therefore \lambda = 6 \times 10^{-7}$ m = 600 nm
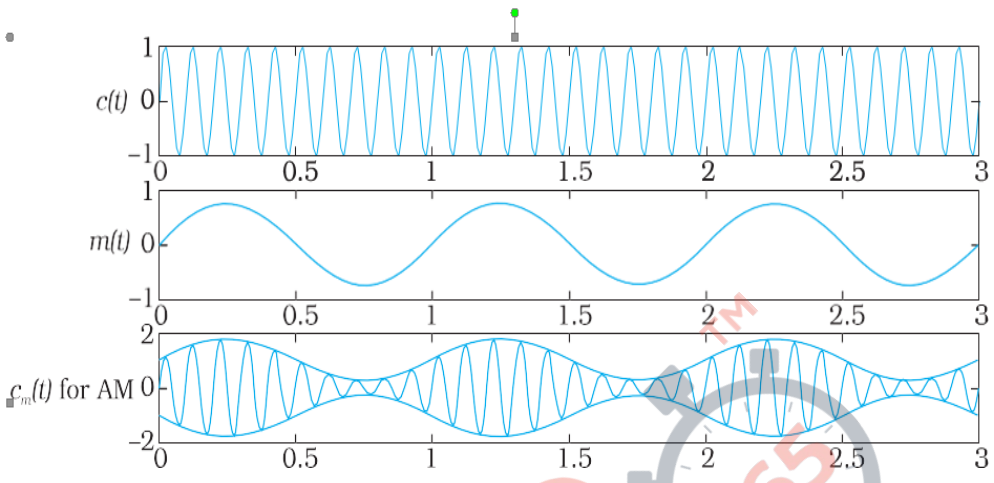
½   3

23.	**SECTION - D**		

	(a) Name of e.m. radiation ½ Mark (b) Method of production ½ Mark (c) Range of wavelength 1 Mark (d) Two values 1 + 1 Marks		
	(a) X-rays	½	
	(b) By using X-ray tubes (Alternatively : By bombarding a metal target with high energy electrons)	½	
	(c) Wave length range of X-rays is from about (10 nm to 10^{-4} nm)	1	
	(d) Alertness, empathy; concern for her mother, knowledgeable (any two)	(1 + 1)	4

24.	**SECTION - E**		
	(a) Finding the electrostatic potential 2 Marks (b) Finding the work done 1 Mark (c) Effect of change of path 1 Mark (d) Potential energy of the system 1 Mark (with justification in each case)		

(a) We have, for a point charge,

$$V = \frac{1}{4\pi \in_0} \frac{q}{r}$$

(i) At point (0, 0, z) :
Potential due to the charge (+q),

$$V_+ = \frac{1}{4\pi \in_0} \frac{q}{(z+a)}$$

Potential due to the charge (-q),

$$V_- = \frac{1}{4\pi \in_0} \frac{(-q)}{(z-a)}$$ ½

Total potential at (0, 0, z) $= \frac{q}{4\pi \in_0} \left[\frac{1}{z+a} - \frac{1}{z-a} \right]$

$$= \frac{-2qa}{4\pi \in_0 (z^2 - a^2)}$$ ½

(ii) At point (x, y, 0)
Potential due to the charge + q

$$V_+ = \frac{1}{4\pi \in_0} \frac{q}{\sqrt{x^2 + y^2 + a^2}}$$

Potential due to the charge (-q)

$$V_- = \frac{1}{4\pi \in_0} \frac{-q}{\sqrt{x^2 + y^2 + a^2}}$$ ½

Total potential at (x, y, 0)

$$= \frac{q}{4\pi \in_0} \left(\frac{1}{\sqrt{x^2 + y^2 + a^2}} - \frac{1}{\sqrt{x^2 + y^2 + a^2}} \right) = 0 \qquad \text{½}$$

Note: Give full credit of part (ii) if a student writes that the point (x,y,0) is equidistant from charges +q and –q, Hence total potential due to them at the given point will be zero.

(b) Work done = q [V_1 - V_2]   ½
$\qquad V_1 = 0$ and $V_2 = 0$ ½
∴ $\qquad$ work done = 0
Where V_1 and V_2 are the total potential due to dipole at point (5,0,0) and (-7,0,0)

(c) There would be no change   ½
$\qquad$ This is because the electrostatic field is a conservative field.   ½

(Alternatively : The work done, in moving a test charge between two given points is independent of the path taken)

(d) The two given charges make an electric dipole of dipole moment $\vec{p} = q.\overrightarrow{2a}$ ½
P.E. in position of unstable equilibrium (where $\vec{p}$ and $\vec{E}$ are antiparallel to each other)
$\qquad = + pE = 2 aq E$ ½

OR

(a)	Finding the total energy before the capacitors are connected	1 Mark
(b)	Finding the total energy in the parallel combination	3 Marks
(c)	Reason for difference	1 Mark

(a) We have
Energy Stored in a capacitor = $\frac{1}{2}CV^2$ ½

∴ Energy stored in the charged capacitors $\quad E_1 = \frac{1}{2}C_1V_1^2 \quad$ And $\quad E_2 = \frac{1}{2}C_2V_2^2$

∴ Total energy stored = $\frac{1}{2}C_1V_1^2 + C_2V_2^2$ ½

(b) Let V be the potential difference across the parallel combination.
Equivalent capacitance = ($C_1 + C_2$)   ½

Since charge is a conserved quantity, we have
$\qquad (C_1 + C_2)V = C_1V_1 + C_2V_2$ ½
⇒ $\qquad V = \left[\frac{C_1V_1 + C_2V_2}{(C_1 + C_2)} \right]$ 1

∴
Total energy stored in the parallel combination

$$= \frac{1}{2}(C_1 + C_2)V^2 \qquad \text{½}$$

$$= \frac{1}{2} \frac{(C_1V_1 + C_2V_2)^2}{(C_1 + C_2)} \qquad \text{½}$$

5

	(c) The total energy of the parallel combination is different (less) from the total energy before the capacitors are connected. This is because some energy gets used up due to the movement of charges during sharing of charge.		1	
25.	a) Drawing the two graphs ½ + ½ b) Drawing the phaser diagram 1 c) i) Naming the devices ½+ ½ ii) Calculating the current flowing 2			

a) The two graphs are as shown

½ +½

b) (The current leads the voltage by an angle Θ where $0 < Θ < \frac{\pi}{2}$). The required phaser diagram is as shown.

[Here Θ= tan⁻¹ $\left[\left(\frac{1}{\omega CR}\right)\right]$]

1

(C) In device X:

Current lags behind the voltage by $\frac{\pi}{2}$

∴ X is an inductor.

½

In device Y:

Current is in phase with the applied voltage

∴ X is a resistor.

½

We are given that

$$0.25 = \frac{220}{X_L}$$
$$\text{or } X_L = \frac{220}{0.25} \, \Omega = 880 \Omega$$

½

$$\text{Also } 0.25 = 0.25 = \frac{220}{X_R}$$
$$\therefore X_R = \frac{220}{0.25} \, \Omega = 880 \Omega$$

½

For the series combination of X and Y,

Equivalent impedance = $\sqrt{X_L^2 + X_R^2} = (880\sqrt{2})\Omega$

½

∴ Current flowing = $\frac{220}{880\sqrt{2}} \, A = 0.177 \, A$

½   5

		OR		
		a) Principal of working – 1 b) Defining efficiency – 1 c) Any two factor – ½ + ½ d) Calculating the current drawn - 2		
		a) A transformer works on the principle of mutual induction. (Alternatively – an emf is induced in the secondary coil when the magnetic flux, linked with it changes with time due to ta (time) changing magnetic flux linked with the primary coil).	1	
		b) The efficiency of a transformer equals the ratio of the output power to the input power. (*Alteratively* : Efficiency = $\frac{output\ power}{input\ power}$ or Efficiency $\frac{V_S\,I_S}{V_P\,I_P}$)	1	
		c) i) Eddy current losses ii) joule heat losses iii) hysteresis losses iv) magnetic flux leakage losses (Any two)	½ +½	
		We have $\frac{V_S\,I_S}{V_P\,I_P}$ = 90% = 0.9	½	
		$\therefore \frac{220}{22}\frac{I_s}{I_p}$ = 0.9		
		$or\ \frac{I_s}{I_p} = \frac{0.9}{0.1} = 9$	½	
		$\therefore I_p = \frac{I_S}{9} = \frac{(22/440)}{9}$ A	½	
		$= \frac{1}{180}$ A		
		= 0.0056A	½	
				5
26		a) Explaining the two processes- 1 + 1 Defining the two terms - ½ + ½ b) Circuit diagram – 1 Working – 1		
		a) The two important processes are diffusion and drift Due to concentration gradient, the electrons diffuse from the n side to the p side and holes diffuse from the ρ side to the n side.	½ ½	

Due to the diffusion, an electric field develops across the junction. Due to the field, an electron moves from the p-side to the n -side, a hole moves from the n-side to the p-side. The flow of the charge carriers due to the electric field, is called drift.

Depletion region:
It is the space charge region on either side of the junction, that gets depleted of free charges, is known as the depletion region.

Potential Barrier
The potential difference, that gets developed across the junction and opposes the diffusion of charge carries and brings about a condition of equilibrium, is known as the barrier potential.

b) The circuit diagram is as shown

Working
In forward bias condition, the direction of the applied voltage is opposite to the barrier potential. This reduces the width of the depletion layer as well as the height of the barrier. A current can, therefore, flow through the circuit. This current increases (non linearly) with increase in the applied voltage.

OR

a) Describing the three factors – 3
b) Drawing the wave forms – 2

a) It is necessary to modulate the audio frequency signals because of the following three reasons:
  i. Size of the antenna or aerial
     This size needs to be comparable to the wavelength of the signal. It would be unmanageably long for audio frequency signals.
  ii. Effective power readiated
     Power radiated, being proportional to $\left(\frac{\ell}{\lambda}\right)^2$ would be very small for a audio frequency signal.
  iii. Mixing up of different signals

The audible frequency range is quite small. Hence if transformisson is done at audio frequencies, the chances of mixing up of different signals are very high. | ½

b) The required wave forms are as shown

    i.   Carrier wave
   ii.   Modulating Signal
  iii.   Amplitude Modulated wave

| ½ |
| ½ |
| 1 |

5