Series OSR

कोड नं. **55/3**
Code No.

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 **15** 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 **30** 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 **15** 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 **30** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minutes 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 घण्टे *अधिकतम अंक : 70*

Time allowed : 3 hours *Maximum Marks : 70*

सामान्य निर्देश :

(i) *सभी प्रश्न अनिवार्य हैं ।*

(ii) *इस प्रश्न-पत्र में कुल **30** प्रश्न हैं । प्रश्न **1** से **8** तक के प्रश्न अति-लघुउत्तरीय प्रश्न हैं और प्रत्येक **एक** अंक का है ।*

(iii) *प्रश्न **9** से **18** में प्रत्येक प्रश्न **दो** अंक का है, प्रश्न **19** से **27** में प्रत्येक प्रश्न **तीन** अंक का है और प्रश्न **28** से **30** में प्रत्येक प्रश्न **पाँच** अंक का है ।*

(iv) *तीन अंकों वाले प्रश्नों में से एक मूल्यपरक प्रश्न है ।*

(v) *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 ।*

(vi) *कैलकुलेटर के उपयोग की अनुमति **नहीं** है । तथापि यदि आवश्यक हो तो आप लघुगणकीय सारणी का प्रयोग कर सकते हैं ।*

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

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

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

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

$\mu_o = 4\pi \times 10^{-7}$ T mA^{-1}

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

$m_e = 9{\cdot}1 \times 10^{-31}$ kg

General Instructions :

(i) *All questions are compulsory.*

(ii) *There are **30** questions in total. Questions No. **1** to **8** are very short answer type questions and carry **one** mark each.*

(iii) *Questions No. **9** to **18** carry **two** marks each, questions **19** to **27** carry **three** marks each and questions **28** to **30** carry **five** marks each.*

(iv) *One of the questions carrying three marks weightage is value based question.*

(v) *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 three questions of five marks each weightage. You have to attempt only one of the choices in such questions.*

(vi) *Use of calculators is **not** permitted. However, you may use log tables if necessary.*

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

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

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

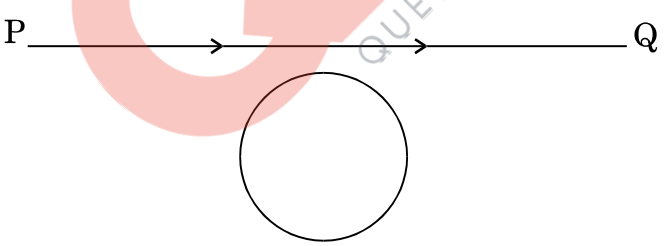
$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T mA^{-1}

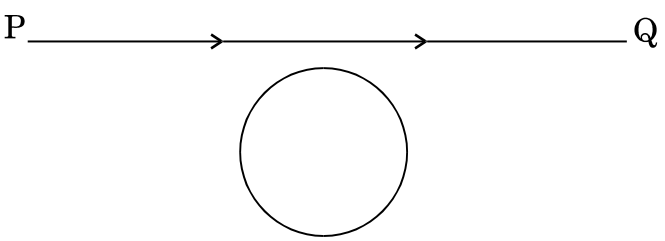
$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9$ N m^2 C^{-2}

$m_e = 9{\cdot}1 \times 10^{-31}$ kg

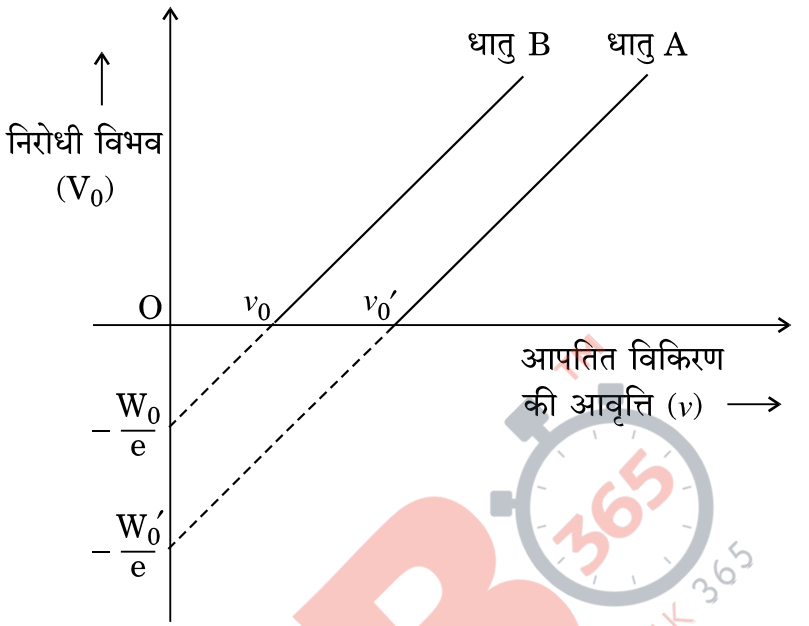
1. चित्र में दर्शाए अनुसार कोई चालक लूप (पाश) किसी धारावाही तार PQ के नीचे स्थित है । लूप में प्रेरित धारा की दिशा ज्ञात कीजिए जब तार में प्रवाहित धारा में निरन्तर वृद्धि हो रही है । *1*



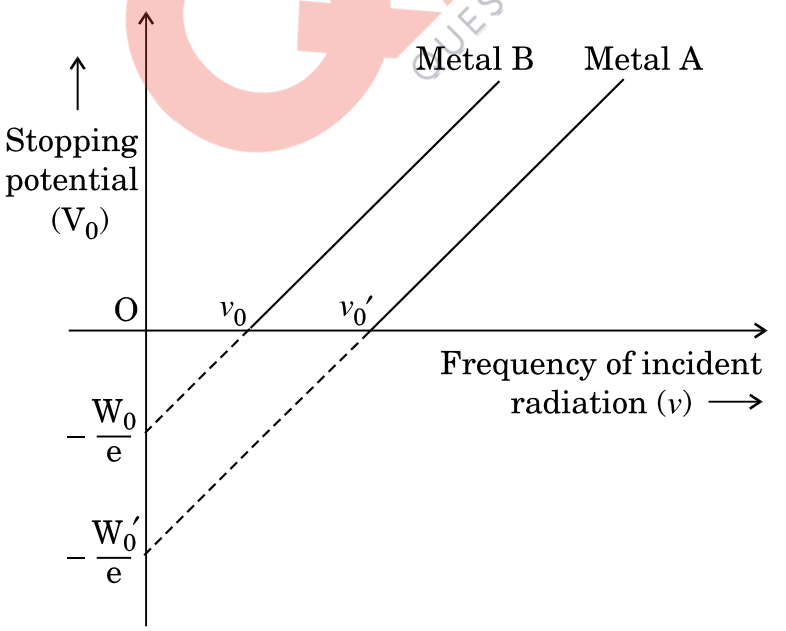
A conducting loop is held below a current carrying wire PQ as shown. Predict the direction of the induced current in the loop when the current in the wire is constantly increasing.



2. ग्राफ़ में दो प्रकाश-सुग्राही धातुओं A और B के लिए, आपतित विकिरण की आवृत्ति ν के साथ निरोधी विभव V_0 का विचरण दर्शाया गया है । इन दोनों धातुओं में से किस धातु की देहली आवृत्ति अधिक है और क्यों ? *1*



The graph shows variation of stopping potential V_0 versus frequency of incident radiation ν for two photosensitive metals A and B. Which of the two metals has higher threshold frequency and why ?



3. अनन्त लम्बाई के दो धारावाही समान्तर चालकों के बीच बल की संकल्पना का उपयोग करते हुए एक ऐम्पियर धारा की परिभाषा दीजिए । *1*

Using the concept of force between two infinitely long parallel current carrying conductors, define one ampere of current.

4. 1·25 अपवर्तनांक के पारदर्शी पदार्थ से बने किसी उभयावतल लेंस को 1·33 अपवर्तनांक के जल में डुबोया गया है । क्या यह लेंस अभिसारी के रूप में व्यवहार करेगा अथवा अपसारी के रूप में ? कारण दीजिए । *1*

A biconcave lens made of a transparent material of refractive index 1·25 is immersed in water of refractive index 1·33. Will the lens behave as a converging or a diverging lens ? Give reason.

5. विद्युत्-क्षेत्र रेखाएँ एक-दूसरे को कभी भी क्यों नहीं काटतीं ? *1*

Why do the electric field lines never cross each other ?

6. 5×10^{11} Hz आवृत्ति की तरंग विद्युत्-चुम्बकीय स्पेक्ट्रम के किस भाग से संबंध रखती है ? *1*

To which part of the electromagnetic spectrum does a wave of frequency 5×10^{11} Hz belong ?

7. नाभिकीय β-क्षय में न्यूट्रिनों का संसूचन प्रायोगिक रूप में कठिन क्यों पाया जाता है ? *1*

Why is it found experimentally difficult to detect neutrinos in nuclear β-decay ?

8. d.c. वोल्टता की तुलना में a.c. वोल्टता के उपयोग को प्राथमिकता क्यों दी जाती है ? दो कारण दीजिए । *1*

Why is the use of a.c. voltage preferred over d.c. voltage ? Give two reasons.

9. किसी समान्तर पट्टिका संधारित्र के आवेशित होने के प्रकरण पर विचार करते हुए यह दर्शाइए कि विस्थापन धारा के कारण पद को सम्मिलित करने के लिए ऐम्पियर के परिपथीय नियम को किस प्रकार व्यापक बनाने की आवश्यकता होती है । *2*

Considering the case of a parallel plate capacitor being charged, show how one is required to generalize Ampere's circuital law to include the term due to displacement current.

10. किसी ताँबे के तार, जिसकी अनुप्रस्थ-काट का क्षेत्रफल $2{\cdot}5 \times 10^{-7}$ m^2 है तथा जिससे $2{\cdot}7$ A धारा प्रवाहित हो रही है, में चालन इलेक्ट्रॉनों की औसत अपवाह चाल का आकलन कीजिए । यह मानिए कि चालन इलेक्ट्रॉनों का घनत्व 9×10^{28} m^{-3} है । *2*

Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area $2{\cdot}5 \times 10^{-7}$ m^2 carrying a current of $2{\cdot}7$ A. Assume the density of conduction electrons to be 9×10^{28} m^{-3}.

11. किसी सेल जिसका विद्युत्-वाहक बल (emf) 'E' तथा आन्तरिक प्रतिरोध 'r' है, किसी चर प्रतिरोधक 'R' के सिरों से संयोजित किया गया है । सेल की टर्मिनल वोल्टता 'V' और धारा 'I' के बीच विचरण को दर्शाने के लिए ग्राफ़ खींचिए । इस ग्राफ़ का उपयोग करके यह दर्शाइए कि सेल का विद्युत्-वाहक बल (emf) और इसके आन्तरिक प्रतिरोध का निर्धारण किस प्रकार किया जा सकता है । *2*

A cell of emf 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing variation of terminal voltage 'V' of the cell versus the current 'I'. Using the plot, show how the emf of the cell and its internal resistance can be determined.

12. धारिता C के किसी समान्तर पट्टिका संधारित्र को विभव V तक आवेशित किया गया । इसके पश्चात् इसे समान धारिता के किसी अन्य संधारित्र, जो आवेशित नहीं है, से संयोजित किया जाता है । संयुक्त निकाय में संचित ऊर्जा और आरम्भ में एकल संधारित्र में संचित ऊर्जा का अनुपात ज्ञात कीजिए । *2*

A parallel plate capacitor of capacitance C is charged to a potential V. It is then connected to another uncharged capacitor having the same capacitance. Find out the ratio of the energy stored in the combined system to that stored initially in the single capacitor.

13. परमाणु के रदरफोर्ड मॉडल का उपयोग करते हुए हाइड्रोजन परमाणु में इलेक्ट्रॉन की कुल ऊर्जा के लिए व्यंजक व्युत्पन्न कीजिए । इलेक्ट्रॉन की कुल ऊर्जा ऋणात्मक होने का क्या अर्थ है ? *2*

अथवा

बोर के परमाणु मॉडल के अभिगृहीतों का उपयोग करके इलेक्ट्रॉन की nवीं कक्षा की त्रिज्या के लिए व्यंजक व्युत्पन्न कीजिए । इस प्रकार बोर की त्रिज्या के लिए व्यंजक प्राप्त कीजिए । *2*

Using Rutherford model of the atom, derive the expression for the total energy of the electron in hydrogen atom. What is the significance of total negative energy possessed by the electron ?

OR

Using Bohr's postulates of the atomic model, derive the expression for radius of n^{th} electron orbit. Hence obtain the expression for Bohr's radius.

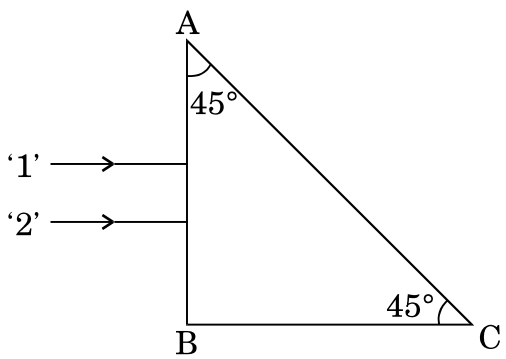
14. (i) अनुचुम्बकीय पदार्थ एवं (ii) प्रतिचुम्बकीय पदार्थ की उपस्थिति में चुम्बकीय क्षेत्र रेखाओं का व्यवहार आरेख खींचकर दर्शाइए । इस विभेदनकारी लक्षण की व्याख्या किस प्रकार की जाती है ? *2*

Show diagrammatically the behaviour of magnetic field lines in the presence of (i) paramagnetic and (ii) diamagnetic substances. How does one explain this distinguishing feature ?

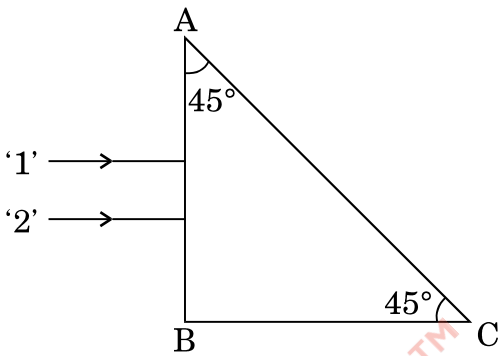
15. परिपथ आरेख की सहायता से किसी p-n संधि डायोड के अर्ध-तरंग दिष्टकारी के रूप में कार्य करने की व्याख्या कीजिए । *2*

Explain, with the help of a circuit diagram, the working of a p-n junction diode as a half-wave rectifier.

16. किसी समद्विबाहु समकोण प्रिज़्म ABC के फलक AB पर दर्शाए अनुसार एकवर्णी प्रकाश की दो किरणें अभिलम्बवत् आपतन करती हैं । काँच के प्रिज़्म के अपवर्तनांक किरणों '1' व '2' के लिए क्रमश: 1·38 और 1·52 हैं । इन किरणों का प्रिज़्म में प्रवेश करने के पश्चात् का पथ आरेखित कीजिए । *2*



Two monochromatic rays of light are incident normally on the face AB of an isosceles right-angled prism ABC. The refractive indices of the glass prism for the two rays '1' and '2' are respectively 1·38 and 1·52. Trace the path of these rays after entering through the prism.



17. CE विन्यास में n-p-n ट्रांज़िस्टर प्रवर्धक का परिपथ आरेख खींचिए । किस अवस्था में यह ट्रांज़िस्टर प्रवर्धक के रूप में कार्य करता है ? *2*

Draw a circuit diagram of n-p-n transistor amplifier in CE configuration. Under what condition does the transistor act as an amplifier ?

18. संचार प्रणाली में निम्नलिखित के कार्य लिखिए : *2*

(i) अभिग्राही

(ii) विमॉडुलक

Write the functions of the following in communication systems :

(i) Receiver

(ii) Demodulator

19. 20 cm फ़ोकस दूरी के किसी उत्तल लेंस को 20 cm वक्रता त्रिज्या के किसी उत्तल दर्पण के समाक्ष एक-दूसरे से 15 cm दूरी पर रखा गया है । कोई बिन्दुकित बिम्ब इस उत्तल लेंस के सामने लेंस से 40 cm दूरी पर रखा जाता है । इस संयोजन द्वारा बने प्रतिबिम्ब की स्थिति ज्ञात कीजिए । प्रतिबिम्ब बनना दर्शाने के लिए किरण आरेख खींचिए । *3*

A convex lens of focal length 20 cm is placed coaxially with a convex mirror of radius of curvature 20 cm. The two are kept 15 cm apart. A point object is placed 40 cm in front of the convex lens. Find the position of the image formed by this combination. Draw the ray diagram showing the image formation.

20. कोई इलेक्ट्रॉन सूक्ष्मदर्शी 50 kV की वोल्टता द्वारा त्वरित इलेक्ट्रॉनों का उपयोग करता है । इलेक्ट्रॉनों से संबद्ध दे-ब्रॉग्ली तरंगदैर्घ्य निर्धारित कीजिए । अन्य कारकों, जैसे आंकिक द्वारक आदि को समान मानते हुए, किसी इलेक्ट्रॉन सूक्ष्मदर्शी की विभेदन क्षमता की तुलना किसी ऐसे प्रकाशिक सूक्ष्मदर्शी जिसमें पीले प्रकाश का उपयोग होता है, कैसे की जाती है ? *3*

An electron microscope uses electrons accelerated by a voltage of 50 kV. Determine the de-Broglie wavelength associated with the electrons. Taking other factors, such as numerical aperture etc. to be same, how does the resolving power of an electron microscope compare with that of an optical microscope which uses yellow light ?

21. ऊर्जा बैंड आरेखों के आधार पर चालकों, अर्धचालकों और विद्युत्-रोधियों के बीच किन्हीं दो विभेदनकारी लक्षणों को लिखिए । *3*

Write any two distinguishing features between conductors, semiconductors and insulators on the basis of energy band diagrams.

22. संचार के दो मूल ढंग (विधाएँ) लिखिए । आयाम मॉडुलन की प्रक्रिया की व्याख्या कीजिए । किसी व्यवस्था आरेख को खींचकर यह दर्शाइए कि किसी ज्यावक्रीय वाहक तरंग पर मॉडुलक सिग्नल के अध्यारोपण द्वारा किस प्रकार आयाम मॉडुलित सिग्नल प्राप्त किया जाता है । *3*

Write two basic modes of communication. Explain the process of amplitude modulation. Draw a schematic sketch showing how amplitude modulated signal is obtained by superposing a modulating signal over a sinusoidal carrier wave.

23. निम्नलिखित के उत्तर दीजिए : *3*

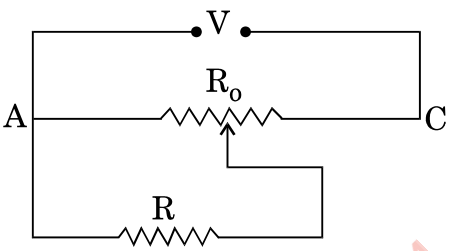
(a) मीटर सेतु में प्रतिरोधकों के बीच संयोजनों को कॉपर की मोटी पट्टी का क्यों बनाया जाता है ?

(b) मीटर सेतु के तार पर सामान्यत: संतुलन बिन्दु को मध्य में प्राप्त करने को प्राथमिकता क्यों दी जाती है ?

(c) मीटर सेतु के तार के लिए किस पदार्थ का उपयोग किया जाता है और क्यों ?

अथवा

चित्र में दर्शाए अनुसार R Ω का कोई प्रतिरोध विभवमापी से धारा लेता है । विभवमापी का कुल प्रतिरोध R_o Ω है । विभवमापी को V वोल्टता की आपूर्ति की जाती है । जब सर्पी सम्पर्क विभवमापी तार के मध्य में है, तब R के सिरों पर वोल्टता के लिए व्यंजक व्युत्पन्न कीजिए । *3*



Answer the following :

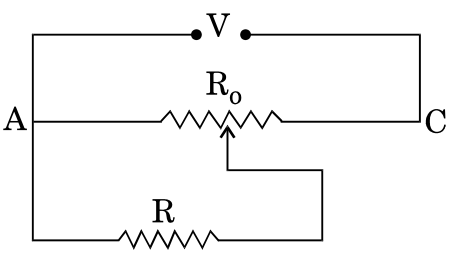
(a) Why are the connections between the resistors in a meter bridge made of thick copper strips ?

(b) Why is it generally preferred to obtain the balance point in the middle of the meter bridge wire ?

(c) Which material is used for the meter bridge wire and why ?

OR

A resistance of R Ω draws current from a potentiometer as shown in the figure. The potentiometer has a total resistance R_o Ω. A voltage V is supplied to the potentiometer. Derive an expression for the voltage across R when the sliding contact is in the middle of the potentiometer.



24. पिछले कुछ समय से आरती अपनी बहन राधा की कुछ दोषपूर्ण शारीरिक गतियों, अस्थिरता और क्रियाकलापों में समन्वय में कमी का प्रेक्षण कर रही थी । वह यदा-कदा तीव्र सिरदर्द की शिकायत भी करती थी । आरती ने अपने माता-पिता से राधा की डॉक्टरी-जाँच का सुझाव दिया । डॉक्टर ने राधा का गहन परीक्षण किया और यह निदान किया कि राधा ब्रेन-ट्यूमर से पीड़ित है ।

(a) आपके अनुसार आरती ने किन मूल्यों को प्रदर्शित किया ?

(b) रेडियोआइसोटोप किस प्रकार डॉक्टरों की ब्रेन-ट्यूमर का निदान करने में सहायता करते हैं ? *3*

For the past some time, Aarti had been observing some erratic body movement, unsteadiness and lack of coordination in the activities of her sister Radha, who also used to complain of severe headache occasionally. Aarti suggested to her parents to get a medical check-up of Radha. The doctor thoroughly examined Radha and diagnosed that she has a brain tumour.

(a) What, according to you, are the values displayed by Aarti ?

(b) How can radioisotopes help a doctor to diagnose brain tumour ?

25. (a) l लम्बाई की किसी छड़ को इसकी लम्बाई के लम्बवत् ऊर्ध्वाधर अधोमुखी कार्यरत एकसमान चुम्बकीय क्षेत्र में एकसमान वेग 'v' से क्षैतिजत: गति करायी जाती है । छड़ के सिरों के बीच प्रेरित विद्युत्-वाहक बल (emf) के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) चालक के मुक्त आवेश वाहकों पर कार्यरत लोरेन्ट्ज़ बल का उपयोग करके इस गतिक विद्युत्-वाहक बल (emf) को किस प्रकार समझा जा सकता है ? व्याख्या कीजिए । *3*

(a) A rod of length l is moved horizontally with a uniform velocity 'v' in a direction perpendicular to its length through a region in which a uniform magnetic field is acting vertically downward. Derive the expression for the emf induced across the ends of the rod.

(b) How does one understand this motional emf by invoking the Lorentz force acting on the free charge carriers of the conductor ? Explain.

26. (a) उपयुक्त आरेख देते हुए, यह दर्शाइए कि परावर्तन द्वारा अध्रुवित प्रकाश को किस प्रकार ध्रुवित किया जा सकता है ।

(b) दो पोलेरॉइडों P_1 तथा P_2 को इस प्रकार रखा गया है कि इनके पारित-अक्ष एक-दूसरे के लम्बवत् हों । तीव्रता I_o का अध्रुवित प्रकाश P_1 पर आपतित है । किसी तीसरे पोलेरॉइड P_3 को P_1 और P_2 के बीच इस प्रकार रखा गया है कि इसका पारित-अक्ष P_1 के पारित-अक्ष से 60° का कोण बनाए । P_1, P_2 और P_3 से गुज़रने वाले प्रकाश की तीव्रता निर्धारित कीजिए । *3*

(a) Show, giving a suitable diagram, how unpolarized light can be polarised by reflection.

(b) Two polaroids P_1 and P_2 are placed with their pass axes perpendicular to each other. Unpolarised light of intensity I_o is incident on P_1. A third polaroid P_3 is kept in between P_1 and P_2 such that its pass axis makes an angle of 60° with that of P_1. Determine the intensity of light transmitted through P_1, P_2 and P_3.

27. किसी श्रेणी LCR परिपथ पर कोई वोल्टता $V = V_o \sin \omega t$ अनुप्रयुक्त की जाती है । एक चक्र में औसत क्षयित शक्ति के लिए व्यंजक व्युत्पन्न कीजिए ।

किस अवस्था में (i) यद्यपि परिपथ में विद्युत् धारा प्रवाहित हो रही है फिर भी शक्ति-क्षय नहीं होता, (ii) परिपथ में अधिकतम शक्ति-क्षय होता है ? *3*

A voltage $V = V_o \sin \omega t$ is applied to a series LCR circuit. Derive the expression for the average power dissipated over a cycle.

Under what condition is (i) no power dissipated even though the current flows through the circuit, (ii) maximum power dissipated in the circuit ?

28. (a) यंग के द्विझिरी प्रयोग में, संक्षेप में वर्णन कीजिए कि द्विझिरी के सामने स्थित पर्दे पर चमकीली और काली धारियाँ (फ्रिंज) किस प्रकार प्राप्त की जाती हैं । इस प्रकार फ्रिंज चौड़ाई के लिए व्यंजक प्राप्त कीजिए ।

(b) यंग के द्विझिरी प्रयोग में निम्निष्ठ और उच्चिष्ठ की तीव्रताओं का अनुपात 9 : 25 है । दोनों झिरीयों की चौड़ाइयों का अनुपात ज्ञात कीजिए । *5*

अथवा

(a) संक्षेप में वर्णन कीजिए कि किसी एकवर्णी प्रकाश स्रोत द्वारा प्रदीप्त किसी एकल पतली झिरी के कारण किसी पर्दे पर विवर्तन पैटर्न किस प्रकार प्राप्त किया जाता है । इस प्रकार द्वितीयक उच्चिष्ठ और द्वितीयक निम्निष्ठ की कोणीय चौड़ाई के लिए शर्तें प्राप्त कीजिए ।

(b) 2×10^{-6} m द्वारक की एकल झिरी द्वारा होने वाले विवर्तन का अध्ययन करने के लिए बारी-बारी से सोडियम के प्रकाश की 590 nm और 596 nm की दो तरंगदैर्घ्यों का उपयोग किया गया । झिरी और पर्दे के बीच की दूरी 1·5 m है । दोनों प्रकरणों में प्राप्त विवर्तन पैटर्नों में पहले उच्चिष्ठ की स्थितियों के बीच पृथकन परिकलित कीजिए । *5*

(a) In Young's double slit experiment, describe briefly how bright and dark fringes are obtained on the screen kept in front of a double slit. Hence obtain the expression for the fringe width.

(b) The ratio of the intensities at minima to the maxima in the Young's double slit experiment is 9 : 25. Find the ratio of the widths of the two slits.

OR

(a) Describe briefly how a diffraction pattern is obtained on a screen due to a single narrow slit illuminated by a monochromatic source of light. Hence obtain the conditions for the angular width of secondary maxima and secondary minima.

(b) Two wavelengths of sodium light of 590 nm and 596 nm are used in turn to study the diffraction taking place at a single slit of aperture 2×10^{-6} m. The distance between the slit and the screen is 1·5 m. Calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases.

29. (a) चुम्बकीय क्षेत्र में किसी आवेशित कण की परिक्रमण आवृत्ति के लिए व्यंजक व्युत्पन्न कीजिए और यह दर्शाइए कि यह आवृत्ति कण के वेग अथवा उसकी ऊर्जा पर निर्भर नहीं है ।

(b) साइक्लोट्रॉन का व्यवस्था आरेख खींचिए । इसकी संरचना का आवश्यक विस्तृत विवरण देते हुए व्याख्या कीजिए कि आवेशित कणों को त्वरित करने के लिए इसका उपयोग किस प्रकार किया जाता है । *5*

अथवा

(a) चल कुण्डली गैल्वेनोमीटर का नामांकित आरेख खींचिए । इसके सिद्धान्त और कार्यप्रणाली का संक्षेप में वर्णन कीजिए ।

(b) निम्नलिखित के उत्तर दीजिए :

(i) गैल्वेनोमीटर की कुण्डली के बीच नर्म लोहे के बेलनाकार क्रोड को रखना क्यों आवश्यक है ?

(ii) किसी गैल्वेनोमीटर की धारा सुग्राहिता में वृद्धि करने का तात्पर्य यह नहीं है कि उसकी वोल्टता सुग्राहिता में भी अनिवार्यतः वृद्धि हो जाएगी । कारण देते हुए व्याख्या कीजिए । *5*

(a) Deduce an expression for the frequency of revolution of a charged particle in a magnetic field and show that it is independent of velocity or energy of the particle.

(b) Draw a schematic sketch of a cyclotron. Explain, giving the essential details of its construction, how it is used to accelerate the charged particles.

OR

(a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.

(b) Answer the following :

(i) Why is it necessary to introduce a cylindrical soft iron core inside the coil of a galvanometer ?

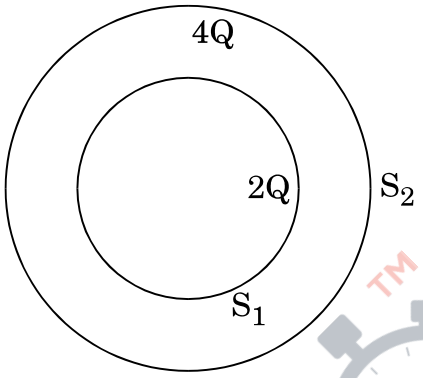
(ii) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason.

30. वान्डे ग्राफ़ जनित्र का नामांकित आरेख खींचिए । यह दर्शाने के लिए कि, किस प्रकार किसी बड़े गोले के भीतर किसी आवेशित छोटे गोले को रखकर बड़े गोले पर विशाल मात्रा में आवेश को स्थानान्तरित किया जा सकता है, इस जनित्र का कार्यकारी सिद्धान्त लिखिए । इस मशीन के उपयोग का उल्लेख कीजिए तथा इसकी सीमाएँ भी लिखिए । *5*

अथवा

(a) किसी एकसमान विद्युत्-क्षेत्र $\vec{E}$ की उपस्थिति में द्विध्रुव आघूर्ण $\vec{p}$ वाले किसी द्विध्रुव पर कार्य करने वाले बल-आघूर्ण के लिए व्यंजक व्युत्पन्न कीजिए ।

(b) चित्र में दर्शाए अनुसार दो खोखले संकेन्द्री गोलों S_1 तथा S_2 पर विचार कीजिए जिन पर क्रमश: 2Q तथा 4Q आवेश परिबद्ध है । (i) इनसे गुज़रने वाले विद्युत् फ्लक्स का अनुपात ज्ञात कीजिए । (ii) यदि S_1 के भीतरी स्थान में वायु के स्थान पर परावैद्युतांक 'ε_r' का कोई माध्यम भर दिया जाए, तो गोले S_1 से गुज़रने वाले विद्युत् फ्लक्स में क्या परिवर्तन होगा ? आवश्यक व्यंजक व्युत्पन्न कीजिए । *5*

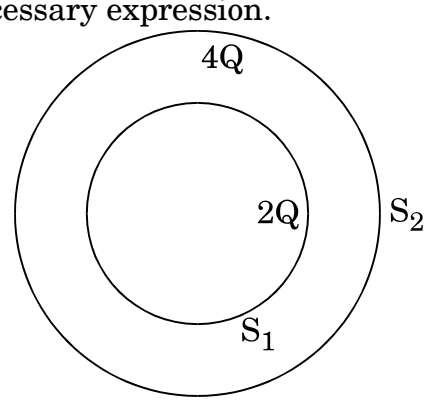


Draw a labelled diagram of Van de Graaff generator. State its working principle to show how by introducing a small charged sphere into a larger sphere, a large amount of charge can be transferred to the outer sphere. State the use of this machine and also point out its limitations.

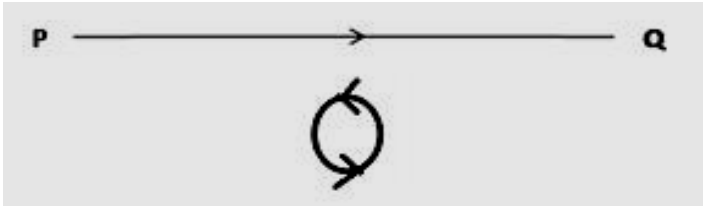
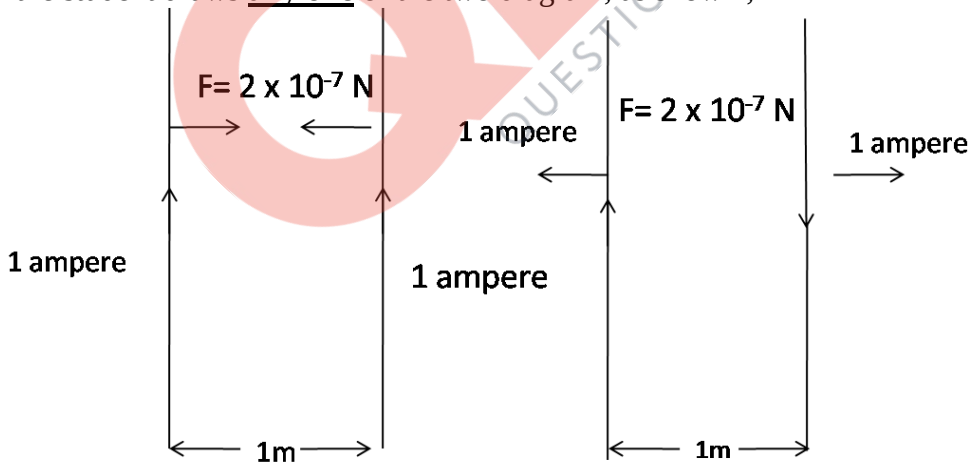
OR

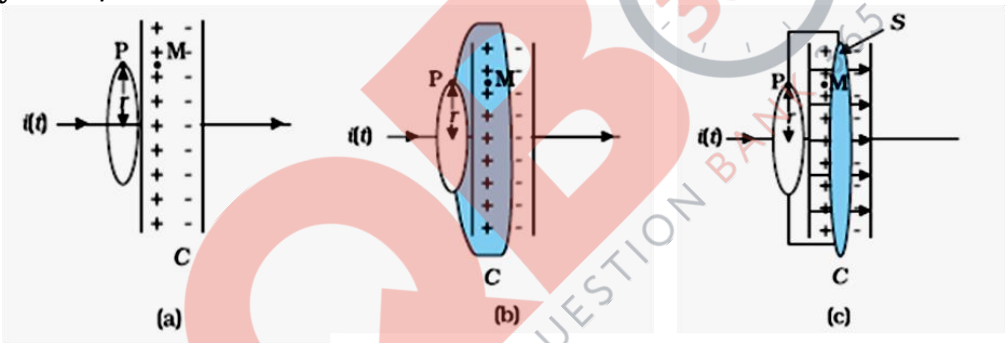
(a) Deduce the expression for the torque acting on a dipole of dipole moment $\vec{p}$ in the presence of a uniform electric field $\vec{E}$.

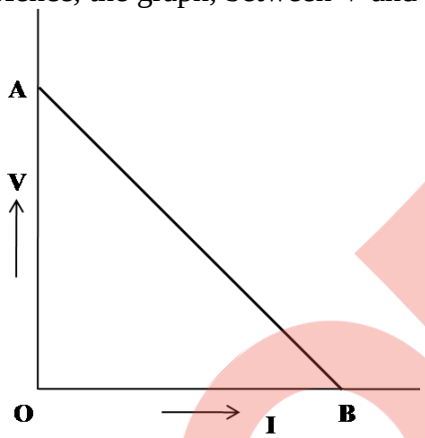
(b) Consider two hollow concentric spheres, S_1 and S_2, enclosing charges 2Q and 4Q respectively as shown in the figure. (i) Find out the ratio of the electric flux through them. (ii) How will the electric flux through the sphere S_1 change if a medium of dielectric constant 'ε_r' is introduced in the space inside S_1 in place of air ? Deduce the necessary expression.

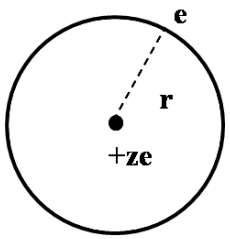


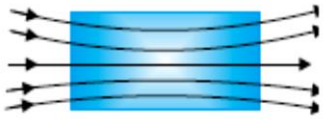
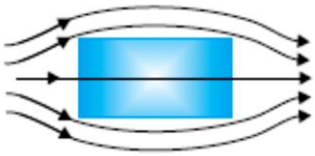
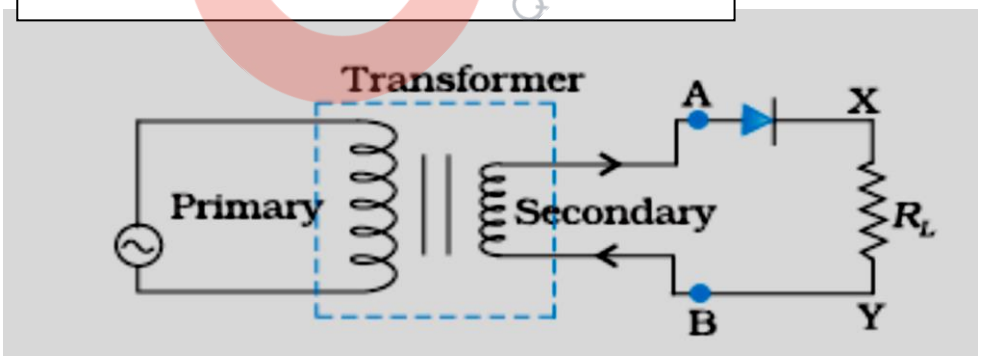
MARKING SCHEME
SET 55/3

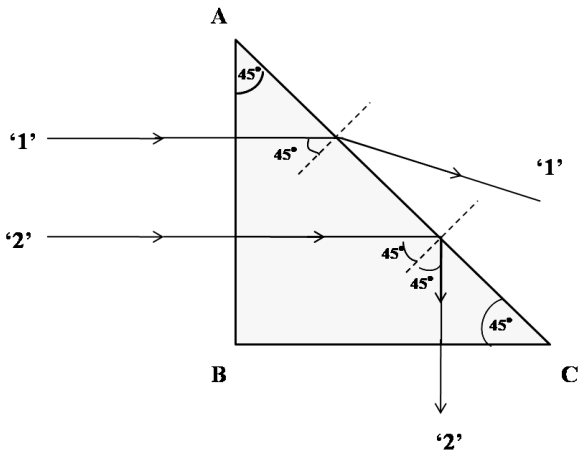
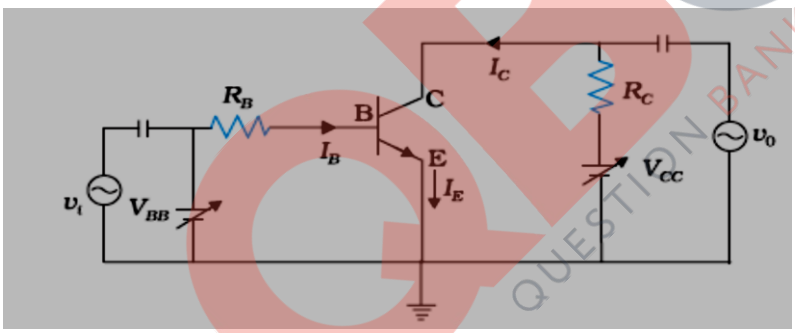
Q. No.	Expected Answer / Value Points	Marks	Total Marks
1.	Anticlockwise  	1	1
2.	Metal A The minimum frequency, at which photoemission starts, is more for metal A **Alternatively:** Work function of A is more.	½ ½	1
3.	**Definition :** One ampere is the value of steady current which when maintained in each of the two very long, straight, parallel conductors of negligible cross section and placed one metre apart in vaccum, would produce on each of these conductors a force equal of 2 x 10^{-7} N/m of its length. ***Alternatively*** If the student writes F = $\frac{\mu_o}{2\pi}\frac{I_1 I_2}{R}$L and says that when $I_1 = I_2 = 1$ *ampere* R= 1 meter and L = 1 meter, then F= 2 x 10^{-7} N ***Award full 1 mark*** ***Alternatively*** If the student draws **any one** of the two diagram, as shown ,  ***Award full 1 mark***	1	1
4.	As a diverging lens Light rays diverge on going from a rarer to a denser medium. [***Alternatively*** Also accept the reason given on the basis of lens marker's formula.]	½ ½	1
5.	At the point of intersection of the two field lines, there will be two directions for the electric field. This is not acceptable.	1	1
6.	Short radio waves (or) microwaves	1	1

7.	Neutrinos are neutral (chargeless), (almost) massless particles that hardly interact with matter. ***Alternatively*** The neutrinos can penetrate large quantity of matter without any interaction **OR** Neutrinos are chargeless and (almost) massless particles.	1	1
8.	**Any two** of the following (or any other correct) reasons : i. AC can be transmitted with much lower energy losses as compared to DC ii. AC voltage can be adjusted (stepped up or stepped down) as per requirement. iii. AC current in a circuit can be controlled using (almost) wattless devices like the choke coil. iv. AC is easier to generate.	½ + ½	1
9.	Statement of Ampere's circuital law ½ Showing inconsistency during the process of charging 1 Displacement Current ½ According to Ampere's circuital Law $\oint \vec{B} d\vec{l} = \mu_0 I$  Applying ampere's circuital law to fig (a) we see that, during charging, the right hand side in Ampere's circuital law equals $\mu_0 I$ However on applying it to the surfaces of the fig (b) or fig (c), the right hand side is zero. Hence, there is a contradiction. We can remove the contradiction by assuming that there exists a current (associated with the changing electric field during charging), known as the displacement current. When this current (= $\frac{d\phi_E}{dt}$) is added on the right hand side, Ampere's circuital law, the inconsisitency disappears. It was, therefore necessary, to generalize the Ampere's circuital law, as $\oint \vec{B} d\vec{l} = \mu_0 I_c + \mu_0 \in_o \frac{d\phi_E}{dt}$ [**Note** : If the student does the reasoning by using the (detailed) mathematics, relevant to displacement current, award full 2 marks]	½ ½ ½ ½	2

10.	Formula ½ Calculation of drift velocity 1 ½ I = AneV_d $V_d = \frac{2.7}{2.5 \times 10^{-7} \times 1.6 \times 10^{-19} \times 9 \times 10^{28}}$ = 7.5 X 10^{-4}m/s	½ ½ 1	2
11.	Relation between V and I ½ Graph ½ Determination of emf and internal resistance ½ + ½ The relation between V and I is V = E – Ir Hence, the graph, between V and I, has the form shown below.  For point A, I=0, Hence, V_A= E For point B, V=0, Hence, E=I_Br Therefore, r = $\frac{E}{I_B}$ **Alternatively**: emf (E) equals the intercept on the vertical axis. Internal resistance (r) equals the negative of the slope of the graph.	½ ½ ½ ½	2
12.	Formula for energy stored ½ New value of capacitance ½ Calculation of ratio 1 Energy stored in a capacitor = $\frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$ (any one) Capacitance of the (parallel) combination = C+C=2C Here, total charge, Q, remains the same ∴ initial energy = $\frac{1}{2}\frac{Q^2}{C}$ And final energy = $\frac{1}{2}\frac{Q^2}{2C}$ ∴ $\frac{final\ energy}{initial\ energy} = \frac{1}{2}$ [**Note** : If the student does the correct calculations by assuming the voltage across the	½ ½ ½ ½	

	(i) Parallel or (ii) Series combination to remain constant (=V) and obtain the answers as (i) 2:1 or (ii) 1:2 , award full marks]		2
13.	Derivation of energy expression 1 ½ Significance of negative sign ½		
	As per Rutherford's model $\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_o}\frac{ze^2}{r^2}$ ⇨ $mv^2 = \frac{1}{4\pi\epsilon_o}\frac{ze^2}{r}$  	½	
	Total energy = P.E +K.E. $= -\frac{1}{4\pi\epsilon_o}\frac{ze^2}{r} + \frac{1}{2}mv^2$	½	
	$= -\frac{1}{2}\cdot\frac{1}{4\pi\epsilon_o}\frac{ze^2}{r} = = -\frac{1}{8\pi\epsilon_o}\frac{ze^2}{r}$	½	
	Negative Sign implies that Electron – nucleus form a bound system.	½	
	Alternatively Electron – nucleus form an attractive system)		2
	OR		
	Bohr's Postulate ½ Derivation of radius of nth orbit 1 Bohr's radius ½		
	For the electron, we have Bohr's Postulate ($mvr=\frac{nh}{2\pi}$)	½	
	$\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_o}\frac{ze^2}{r^2}$ and $mvr = \frac{nh}{2\pi}$	½	
	$\therefore m^2v^2r^2 = \frac{n^2h^2}{4\pi^2}$ and $mv^2r = \frac{1}{4\pi\epsilon_o}ze^2$	½	
	$\therefore r = \frac{\epsilon_o n^2h^2}{\pi ze^2m}$	½	
	Bohr's radius (for n = 1) = $\epsilon_o \; h^2/\pi ze^2m$		2

14.	Diagrams ½ + ½ Explanations ½ + ½		
		½	
		½	
	A <u>paramagnetic</u> material tends to move from weaker to stronger regions of the magnetic field and hence increases the number of lines of magnetic field passing through it. [***Alternatively:*** A <u>paramagnetic</u> material, dipole moments are induced in the direction of the field.]	½	
	A <u>diamagnetic</u> material tends to move from stronger to weaker regions of the magnetic field and hence, decreases the number of lines of magnetic field passing through it. [***Alternatively:*** A <u>diamagnetic</u> material, dipole moments are induced in the opposite direction of the field.] [**Note**: If the student just writes that a paramagnetic material has a small positive susceptibility ($0< X < \varepsilon$) and a diamagnetic material has a negative susceptibility ($-1\leq X < 0$), award the ½ mark for the second part of the question.]	½	2
15.	Circuit diagram 1 Working 1		
		1	
	<u>Working</u>: During one half of the input AC, the diode is forward biased and a current flows through R_L. During the other half of the input AC, the diode is reverse biased and no current flows through the load R_L. Hence, the given AC input is rectified [**Note** : If the student just draws the waveforms, for the input AC voltage and output voltage (without giving any explanation) (award ½ mark only for "working")	½ ½	2

16.	Tracing the path of the two rays 1 + 1  [**Note** : If the student just writes that angle of incidence for both rays '1' and '2' on face AC = 45° and says that it is less than critical angle for ray '1' (which therefore gets refracted) and more than critical angle for ray '2' (which undergoes total internal reflection) ***Award ½ + ½ marks***	1 1	2
17.	Circuit diagram 1 ½ Condition ½  **Condition :** The transistor must be operated close to the centre of its active region. ***Alternatively*** The base- emitter junction of the transistor must be (suitably) forward biased and the collector – emitter junction must be (suitably) reverse biased.	1 ½ ½	2
18.	Function of receiver 1 Function of Demodulator 1 <u>Receiver:</u> It extracts the desired message signals from the received signals at the channel output. <u>Demodulator:</u> It is a device to retrieve information (or) the message signal from the carrier wave at the receiver.	1 1	2

19.

Position of the final image (formed by the lens-mirror combination)	2
Ray diagram	1

For the lens:

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$$ ½

U= - 40 cm, f= +20 cm This gives v= + 40cm

This image acts as a (virtual) object for the convex mirror

$\therefore u=(+40-15)cm=25cm$ ½

Also f= $+\frac{20}{2}cm=+10\ cm$

From

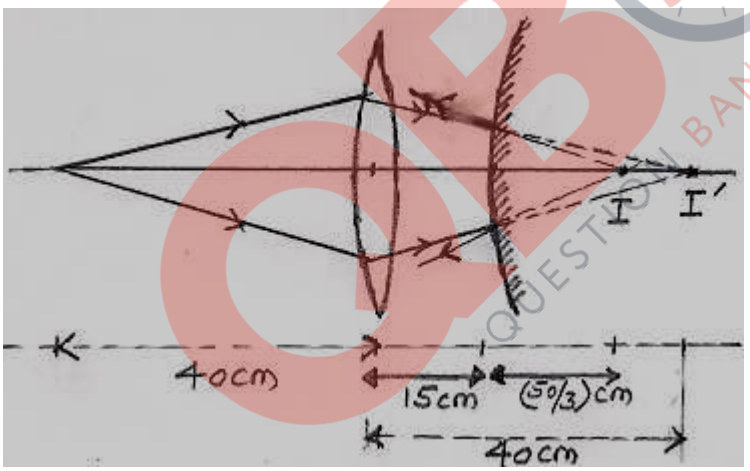
$\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$

We get

$$v=\frac{50}{3}cm\simeq 16.67cm$$ ½

The final image is, therefore formed at a distance of 16.67 cm($\frac{50}{3}cm$) to the right of the convex mirror.

(at a distance of 31.67 cm (=$\frac{95}{3}cm$) to the right of the convex lens. ½



1

3

20.

Formula	½
Calculation of debroglie wavelength	2
Comparison	½

$\lambda=\frac{h}{p}=\frac{h}{\sqrt{2meV}}$ or $\lambda=\frac{12.27}{\sqrt{V}}A^{o}$ ½

$$\therefore \lambda=\frac{6.63\times 10^{-34}}{\sqrt{(2\times 9.1\times 10^{-31}\times 1.6\times 10^{-19}\times 50\times 10^{3})}}$$ 1

$\lambda= 5.33\times 10^{-12}$m 1

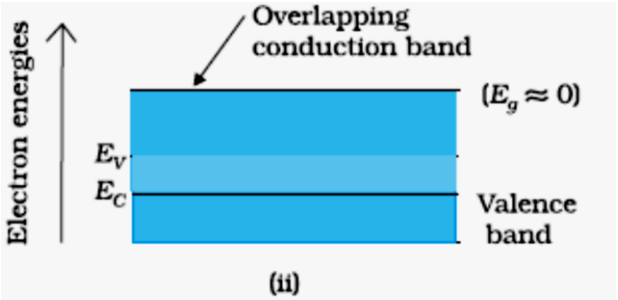
The resolving power of an electron microscope is much better than that of optical microscope. ½

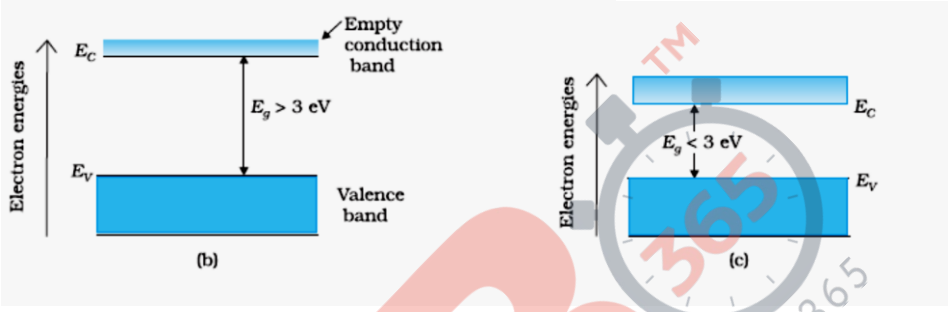
[**Note** : If the student writes R.P $\alpha\ \frac{1}{\lambda}$, award this ½ mark]

3

21.

Energy band diagrams	1 ½
Two distinguishing features	1 ½





½

½ + ½

Two distinguishing features:

(i) In conductors, the valency band and conduction band tend to overlap (or nearly overlap) while in insulators they are seperated by a large energy gap and in semiconductors are separated by a small energy gap.

1

(ii) The conduction band, of a conductor, has a large number of electrons available for electrical conduction. However the conduction band of insulators is almost empty while that of the semi- conductor has only a (very) small number of such electrons avilable for electrical conduction.

½

3

22.

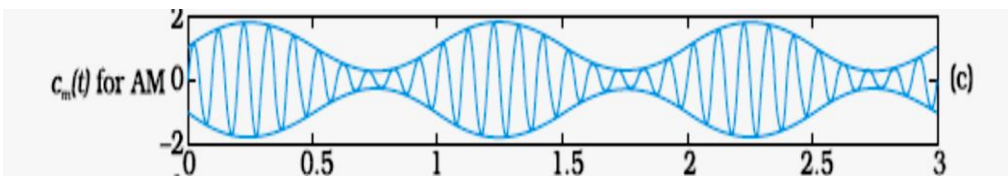
Two basic modes of communication	½ + ½
Process of Amplitude Modulation	1
Schematic Sketch	1

Two basic modes of communication are

i. Point – to –point ½

ii. Broadcast ½

In Amplitude modulation the amplitude of a carrier wave is made to vary, with time, in the same way as the modulating signal varies with time 1



1

3

23.

Answers to each of the three parts 1+1+1=3

a) This is to ensure that the connections do not contribute any extra, unknown, resistances in the circuit. — 1

b) This is done to minimize the percentage error in the value of the unknown resistance.
[***Alternatively:*** This is done to have a better " balancing out" of the effects of any irregularity or non-uniformity in the metre bridge wire.
Or
This can help in increasing the senstivity of the metre bridge circuit.] — 1

c) Manganian / constantan /Nichrome
This material has a low temperature **(any one)** of coefficient of resistance/ high reisistivity. — ½ + ½

3

OR

Calculation of total resistance of the circuit	1
Calculation of total current drawn from the voltage Source	½
Calculation of current through R	1
Calculation of potential drop across R	½

$$R_{total} = \frac{R_o}{2} + \frac{\frac{R_o}{2}.R}{\frac{R_o}{2}+R} \quad \text{— ½}$$

$$= \frac{R(R_o+4R)}{2(R_o+2R)}$$

$$I_{(total)} = \frac{V}{R_{total}} \quad \text{— ½}$$

$$\text{Current through R} = I_2 = I_{total} \times \frac{\frac{R_o}{2}}{\frac{R_o}{2}+R} \quad \text{— ½}$$

$$= I_{total} \times \frac{R_o}{R_o+2R} \quad \text{— ½}$$

$$= \frac{V.2(R_o+2R)}{R(R_o+4R)} \times \frac{R_o}{R_o+2R}$$

$$= \frac{2VR_o}{R(R_o+4R)} \quad \text{— ½}$$

$$\text{Voltage across R} = I_2 R = \left(\frac{2VR_o}{R_o+4R}\right) \quad \text{— ½}$$

3

24.

Values displayed	2
Diagnosis	1

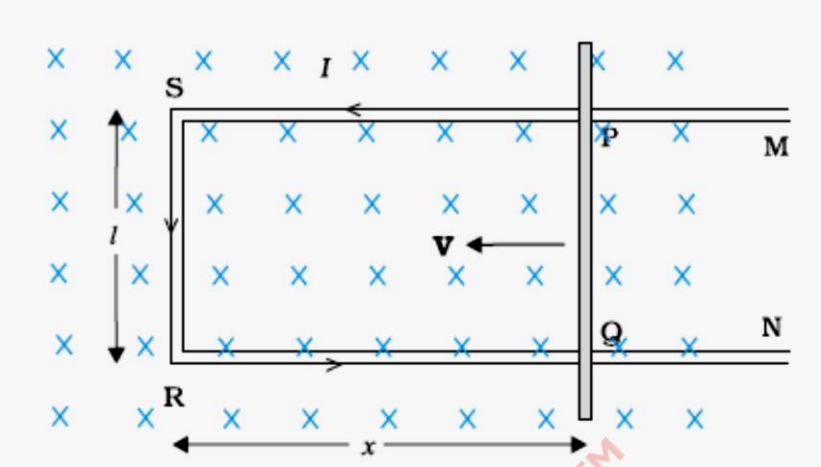
(a) keen observer/ helpful/ concerned / responsible/ respectful towards elders. (**Any two**) — 1+1

(b) The doctor can trace and observe, the difference between the movement of an appropriate radio- isotope through a normal brain and a brain having tumor in it. — 1

[**Note** : Also accept any other appropriate explanation.]

3

25.	(a) Deriving the expression for the induced emf 2 (b) Understanding motional emf in terms of Lorentz force 1		



½

(a) Imagine the rod PQ to be moving with a velocity **v** from its initial (varying) position towards some position SR.
The magnetic flux, enclosed by the loop PQRS , at the instant shown,is

$\varphi = Blx$ ½

$\therefore e = -\frac{d\varphi}{dt} = -Bl\frac{dx}{dt}$ ½

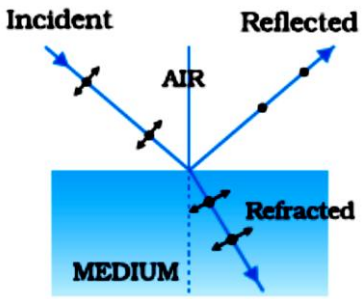
$= Blv \quad (\because v = -\frac{dx}{dt})$ ½

(b) Lorentz force, on a charge q, moving with a speed v, in a (normal) uniform magnetic field B, is Bqv
All charges experience the same force. Work done to move the charge from P to Q, is W = Bqv× l

$\therefore e = \frac{W}{q} = \frac{Bqvl}{q} = Blv$ ½ ½ 3

26.	a) Polarization by reflection 1 ½ b) Intensity of light passing through P_1, P_2, P_3 ½ + ½ + ½		

(a) When unpolarised light is incident on the boundary between two transparent media, the reflected light gets plane polarized with its electric vector perpendicular to the plane of incidence. ½

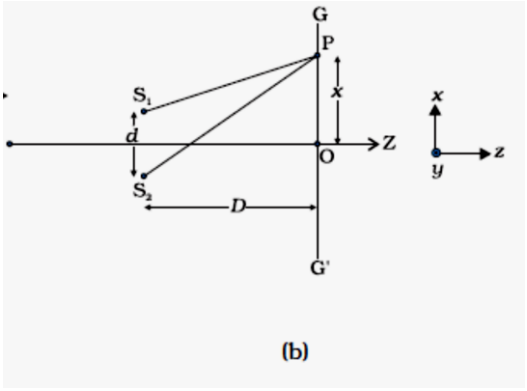


½

	The polarization is complete when the reflected and refracted rays are at right angles to each other. This condition occurs for an angle of incidence, i_p, where tan $i_p = \mu$ [**Note** : Award this 1 mark even if the student writes about Brewster's law and says that the reflected light is totally polarised when the angle of incidence, i_p equals $\tan^{-1} \mu$] (b) Intensity of light through $P_1 = \frac{I_o}{2}$ Intensity of light through $P_2 = \frac{I_o}{2}\cos^2 60$ $= \frac{I_o}{2} \cdot \left(\frac{1}{2}\right)^2 = \frac{I_o}{8}$ Intensity of light through $P_3 = \frac{I_o}{8}\cos^2 30 = \frac{I_o}{8} \times \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3I_o}{32}$ [**Note**: If the students takes the intensity of light, transmitted through P_1, as I_o, and calculates the intensity of light, transmitted by P_2 and P_3, as $\frac{I_o}{4}$ and $\frac{3I_o}{16}$, award ½ + ½ = 1 mark only.]	½ ½ ½ ½	3
27.	Deriving the expression for average power 2 Condition for no power dissipation ½ Condition for maximum power dissipation ½ Applied voltage = $V_0 \sin \omega t$ Current in the circuit = $I_o \sin(\omega t - \phi)$ where ϕ is the phase lag of the current with respect to the voltage applied , Hence instantaneous power dissipation $= V_0 \sin \omega t \times I_o \sin(\omega t - \phi)$ $= \frac{V_0 I_0}{2}[2 \sin \omega t . \sin(\omega t - \phi]$ $= \frac{V_0 I_0}{2}[\cos \phi - \cos(2\omega t - \phi]$ Therefore, average power for one complete cycle = average of$[\frac{V_0 I_0}{2}[\cos \phi - \cos(2\omega t - \phi]]$ The average of the second term over a complete cycle is zero . Hence , average power dissipated over one complete cycle = $\frac{V_0 I_0}{2}\cos \phi$ [**Note** : Please also accept alternative correct approach.] Conditions (i) No power is dissipated when R = 0 (or $\phi = 90^o$) [**Note:** Also accepts if the student writes 'This condition cannot be satisfied for a series LCR circuit".] (ii) Maximum power is dissipated when $X_L = X_C$ or $\omega L = \frac{1}{\omega C}$ (or $\phi = 0$)	½ ½ ½ ½ ½ ½	3
28.	(a) Formation of bright and dark fringes 1 Obtaining the expression for fringe width 3 (b) Finding the ratio 1 (a) The light rays from the two (coherent) slits, reaching a point 'P' on the screen, have a path difference ($S_2P - S_1P$).The point 'P' would, therefore be a		

i. Point of maxima(bright fringe), if $S_2P - S_1P = n\lambda$. ½

ii. Point of minima (dark fringe), if $S_2P - S_1P = (2n+1)\frac{\lambda}{2}$ ½



(b) ½

We have

$(S_2P)^2 - (S_1P)^2 = \left\{D^2 - \left(x + \frac{d}{2}\right)^2\right\} - \left\{D^2 + \left(x - \frac{d}{2}\right)^2\right\}$

$= 2xd$

$S_2P - S_1P = \frac{2xd}{S_2P + S_1P} \approx \frac{2xd}{2D} = \frac{xd}{D}$ ½

∴ We have maxima at points, where ½

$$\frac{xd}{D} = n\lambda$$

and minima at points where

$$\frac{xd}{D} = \left(\frac{2n+1}{2}\right)\lambda$$ ½

Now, fringe width $\boldsymbol{\beta}$= separation between two successive maxima(or two successive minima) = $x_n - x_n - 1$ ½

$\therefore \boldsymbol{\beta} = \frac{\lambda D}{d}$ ½

(b) We have

$$\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{25}{9}$$ ½

$$\therefore = \frac{a_1}{a_2} = \frac{4}{1}$$

$$\therefore \frac{W_1}{W_2} = \frac{I_1}{I_2} = \frac{(a_1)^2}{(a_2)^2} = \frac{16}{1}$$ ½

[**Note:** Give ½ mark if the student just writes Intensity ∝ width

5

OR

a) Obtaining the diffraction pattern	1 ½
Conditions for angular width	1 ½
b) Calculation of separation	2

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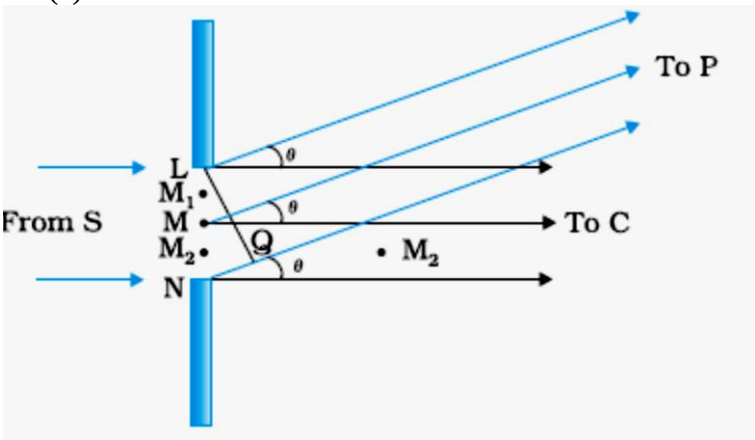
(a)



½

½

The path difference (NP-LP) , between the two edges of the slit, is given by

½

NP-LP ≅ NQ = a sin$\theta \approx a\theta$

We, therefore, get maxima and minima, at different points of the screen, depending on the path difference between the contributions from the wavelets, emanating from different points of the slit. This results in a diffraction pattern on the screen.

½

The path difference between two points M_1 , M_2, in the slit plane, seperated by a distance 'y', is yθ.

At the central point, 'C', on the screen, 'θ' is zero.

All parts of the slit contribute in phase

½

Hence 'C' is a maximum.

At all points where '$\theta' \cong (n + \frac{1}{2})\frac{\lambda}{a}$, we get (secondary) maxima of varying intensity. This is because of the non-zero contribution of a (decreasing)part of the slit at these points.

½

At all points where $\theta \approx \frac{n\lambda}{a}$, we get minima.

This is because of a net (almost) zero contribution of the whole slit at these points.

½

[**Note** : Please also accept alternative correct diagram with appopriate explanation.]

(b) Angular width of the secondary maxima $\approx 2(2n+1)\frac{\lambda}{a}$

½

$\therefore$ Linear width = $[(2n+1)\frac{\lambda}{a}]$ D

$\therefore$ Linear seperation, between the first maxima (n=1) of the two wavelengths, on the screen, is

$$\frac{3(\lambda_2 - \lambda_1)}{a} \times D$$

$\therefore$ Seperation = $\frac{3(596-590)\times10^{-9}}{2\times10^{-6}} \times 1.5m$

1

= 13.5 x $\times 10^{-3}$m (= 13.5 mm)

5

29.

(a) Expression for frequency	1 ½
Frequency Independent of 'v' or energy	½
(b) Sketch of cyclotron	1
Construction	1
Working	1

(a) When a particle of mass 'm' and charge 'q' , moves with a velocity $\boldsymbol{v}$, in a uniform magnetic field $\boldsymbol{B}$, it experiences a force $\boldsymbol{F}$ where

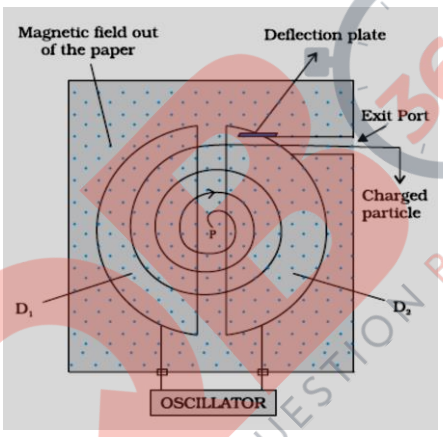
$$\vec{F} = q\,(\vec{v} \times \vec{B})$$ ½

$\therefore$ Centripetal force $\frac{mv^2}{r} = 2\,v\,B_\perp$ ½

$\therefore r = \frac{mv}{qB_\perp}$

$\therefore$ frequency = $\frac{v}{2\pi r} = \frac{qB_\perp}{2\pi m}$ ½

$\therefore$It is independent of the velocity or the energy of the particle. ½



1

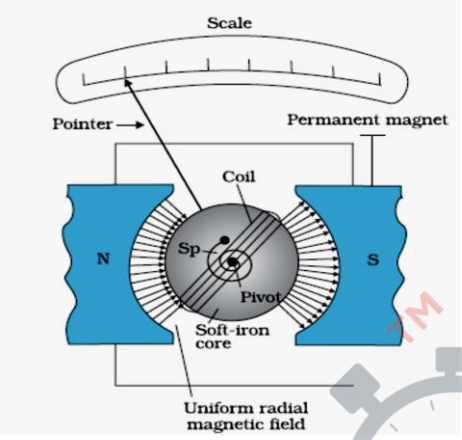
Construction: The cyclotron is made up of two hollow semi-circular disc like metal containers, D_1 and D_2, called dees.
It uses crossed electric and magnetic fields. The electric field is provided by an oscillator of adjustable frequency. 1

[**Note**: Award this mark even if the student labels the diagram properly without writing the details of the construction.]

Working: In a cyclotron, the frequency of the applied alternating field is adjusted to be equal to the frequency of revolution of the charged particles in the magnetic field. This ensures that the particles get accelerated every time they cross the space between the two dees. The radius of their path increases with increase in energy and they are finally made to leave the system via an exit slit. 1 5

OR

(a) Labelled diagram	1
Principle and working	2
(b) i) Reason for cylindrical soft iron core	1
ii) Comparison of current sensitivity and voltage sensitivity	1



1

Principle and working : A current carrying coil, placed in a uniform magnetic field, (can) experience a torque ½

Consider a rectangular coil for which no. of turns = N,
Area of cross- section = l×b=A,
Intensity of the uniform magnetic field=B,
Current through the coil=I
∴ Deflecting torque = $BIL \times b = BIA$
$For\ N\ turns \quad \tau$ =NBIA
Restoring torque in the spring = kθ ½

(k=restoring torque per unit twist)

$$\therefore NBIA = k\theta$$

$$\therefore I = \left(\frac{k}{NBA}\right)\theta$$ ½

$$\therefore I \propto \theta$$

The deflection of the coil, is, therefore, proportional to the current flowing through it. ½

(b) (i) The soft iron core not only makes the field radial but also increases the strength of the magnetic field. **1**
[**Note**:- Award this one mark even if the student writes just one of the two reasons given above)

(ii) We have

Current sensitivity = $\frac{\theta}{I}$ = NBA/k ½

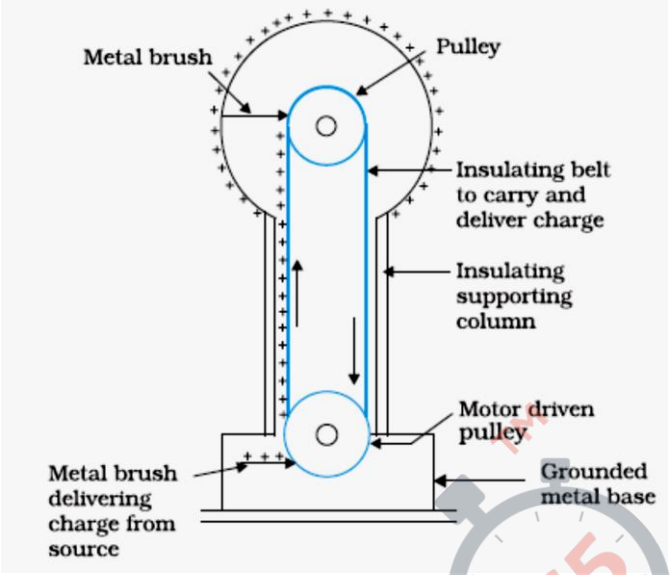
Voltage sensitivity = $\frac{\theta}{V} = \frac{\theta}{IR} = \left(\frac{NBA}{k}\right).\frac{1}{R}$ ½

It follows that an increase in current senstivity may not necessarily increase the voltage sensitivity.

5

30.

Diagram	2
Principle and working	2
Use and limitation	½ + ½

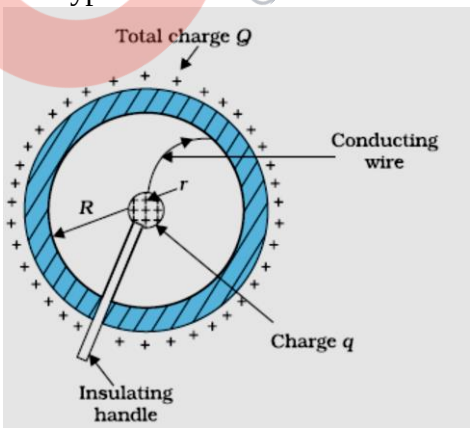


2

[**Note** : Award 1 mark only if the diagram is not labelled]

Principle & working

Consider a set up of the type shown here



i. Potential inside and on the surface, of the conducting sphere pf radius 'R':

$V'_R = \frac{1}{4\pi\epsilon_o}.\frac{Q}{R}$

ii. Potential due to small sphere of radius 'r' carrying a charge 'q':

At the surface of the smaller sphere : $V'_r = \frac{1}{4\pi\epsilon_o}.\frac{q}{r}$

½

At the surface of the larger sphere : $V_R'' = \frac{1}{4\pi\epsilon_o}.\frac{Q}{R}$

∴ The difference of potential between the smaller and the larger sphere:

$=\Delta V = \frac{1}{4\pi\epsilon_o}.\left[\left(\frac{Q}{R}+\frac{q}{r}\right)-\left(\frac{Q}{R}+\frac{q}{r}\right)\right]$ ½

$= \frac{q}{4\pi\epsilon_o}\left(\frac{1}{r}-\frac{1}{R}\right)$

When 'q' is positive, the inner sphere would always be at a higer potential with respect to outer sphere, irrespective of the amount of charges on the two. ½

∴ When both the spheres are connected, charge will flow from the smaller sphere to the larger sphere. Thus for a set up of the type shown, charge would keep on pilling up on the larger sphere. ½

Use : This machine is used to accelerate charged particles (electron, protons, ions) to high energies. ½

Limitation:It can build up potentials upto a few million volts only. ½ 5

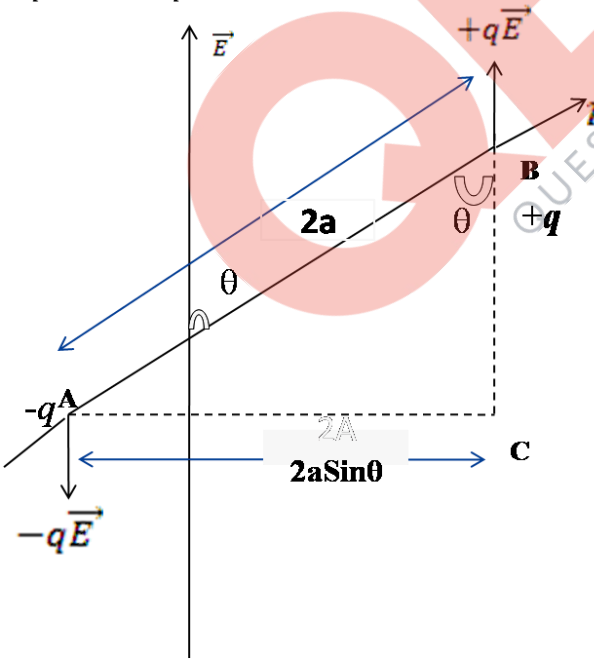
OR

(a)	Deducing the expression for torque	2
(b)	Finding the ratio of the flux through the two spheres	2
(c)	Finding the change in flux	1

(a)

The forces, acting on the two charges of the dipole, are ½

$+q\vec{E}$ and $-q\vec{E}$



½

The net force on the dipole is zero.

The two forces are, however, equivalent to a torque having a magnitude

$\tau = (qE)AC$

$= qE.\ 2a \sin\theta$

$= pE \sin\theta$ ½

	The direction of this torque is that of the cross product $(\vec{p} \times \vec{E})$. Hence, the torque acting on the dipole, is given by $\vec{\tau} = \vec{p} \times \vec{E}$	½	
	(b) As per Guass's Theorem Electric Flux = $\oint_s \vec{E}.\vec{dS} = \frac{q_{enclosed}}{\epsilon_o}$	½	
	∴ For sphere S_1, flux enclosed = $\phi_1 = \frac{2Q}{\epsilon_o}$	½	
	For sphere S_2 , flux enclosed = $\phi_2 = \frac{2Q+4Q}{\epsilon_o} = \frac{6Q}{\epsilon_o}$	½	
	∴ $\frac{\phi_1}{\phi_2} = \frac{1}{3}$	½	
	When a medium of dielectric consistent ϵ_r is introduced in sphere S_1 the flux through S_1 would be $\phi_1' = \frac{2Q}{\epsilon_r}$ [Also award this mark if the student writes $\phi_1 = \frac{2Q}{\epsilon_o \epsilon_r}$] [**Note** : If the student just writes that the flux through S_1 decreases, award ½ mark only.]	1	5