Questions from the Compartment examination Paper -2009

1. State the relation between the frequency, ν, of radiation, emitted by a LED, and the band gap energy, E_g, of the semiconductor used to fabricate it. *1*

किसी प्रकाश उत्सर्जक डायोड (LED) की संरचना के लिए उपयोग होने वाले अर्धचालक की बैंड अन्तराल ऊर्जा, E_g तथा इसके द्वारा उत्सर्जित विकिरणों की आवृत्ति ν के बीच सम्बन्ध लिखिए ।

2. Why is small ozone layer on top of the stratosphere crucial for human survival ? *1*

समतापमंडल के शीर्ष पर ओज़ोन की पतली परत मानव की उत्तरजीविता के लिए महत्त्वपूर्ण क्यों है ?

3. Point out 'right' or 'wrong' for the following statements : *1*

(a) The mutual forces between two charges do not get affected by the presence of other charges.

(b) The potential, due to a dipole, at any point on its axial line, is zero.

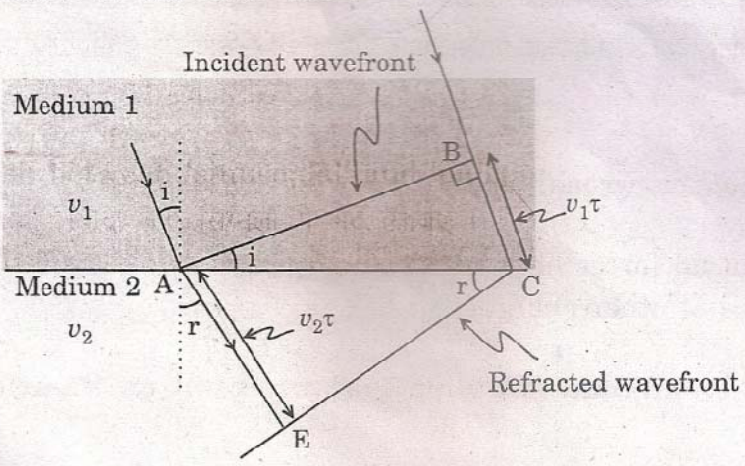
4. The three coloured bands, on a carbon resistor are red, green and yellow respectively. Write the value of its resistance.
किसी कार्बन प्रतिरोधक पर तीन रंगीन बैंड क्रमशः लाल, हरा तथा पीले रंग के हैं । इसके प्रतिरोध का मान लिखिए ।

5. Define the term 'magnetic inclination'.
'चुम्बकीय आनति' की परिभाषा लिखिए ।

6. Distinguish between 'sinusoidal' and 'pulse shaped' signals.
'ज्यावक्रीय' तथा 'स्पन्द रूप' सिग्नलों में भेद कीजिए ।

7. An a.c. current, $I = I_0 \sin \omega t$, produces a certain heat, H, in a resistor R, over a time $T = 2\pi/\omega$. Write the value of the d.c. current that would produce the same heat, in the same resistor, in the same time.
कोई प्रत्यावर्ती (a.c.) धारा, $I = I_0 \sin \omega t$ समय $T = 2\pi/\omega$ में किसी प्रतिरोध R में एक निश्चित ऊष्मा H उत्पन्न करती है । उस दिष्ट (d.c.) धारा का मान लिखिए जो उतने ही समय में, उसी प्रतिरोधक में, उतनी ही ऊष्मा उत्पन्न करे ।

8. The diagram, given below, shows the refraction of a plane wavefront, incident on the surface PP′ separating two media, (1) and (2). Which of the two media is the rarer one ?



A message signal of frequency 10 kHz and peak voltage of 10 volts is used to modulate a frequency of 1 MHz and peak voltage of 20 volts. Determine (i) modulation index, (ii) the side bands produced. 2

10 kHz आवृत्ति तथा 10 वोल्ट शिखर वोल्टता के किसी संदेश सिग्नल का उपयोग किसी 1 MHz आवृत्ति तथा 20 वोल्ट शिखर वोल्टता के माडुलन के लिए किया गया है । (i) माडुलन सूचकांक, (ii) उत्पन्न पार्श्व बैण्ड ज्ञात कीजिए ।

). Two concentric circular coils, one of small radius r_1 and the other of large radius r_2, such that $r_1 << r_2$ are placed coaxially with centres coinciding. Obtain the mutual inductance of the arrangement. 2

दो संकेन्द्री वृत्ताकार कुंडलियाँ, एक कम त्रिज्या r_1 की तथा दूसरी अधिक त्रिज्या r_2 की, ऐसी कि $r_1 << r_2$, समाक्षी रखी हैं तथा दोनों के केन्द्र संपाती हैं । इस व्यवस्था के लिए अन्योन्य प्रेरकत्व ज्ञात कीजिए ।

. A cyclotron, when being used to accelerate positive ions (mass = $6{\cdot}7 \times 10^{-27}$ kg, charge = $3{\cdot}2 \times 10^{-19}$ C) has a magnetic field of $(\pi/2)$ tesla applied normal to the plane of its dees. What must be the value of the frequency of the applied alternating electric field to be used in it ? 2

12. Two charges + Q and − Q are kept at $(-x_2, 0)$ and $(x_1, 0)$ respectively in the x-y plane. Find the magnitude and direction of the net electric field at the origin (0, 0).

OR

Draw the shapes of the suitable Gaussian surfaces, while applying Gauss's law to calculate the electric field due to

(a) a uniformly charged long straight wire,

(b) a uniformly charged infinite plane sheet.

दो आवेश + Q और − Q, x-y तल में क्रमशः $(-x_2, 0)$ और $(x_1, 0)$ पर स्थित हैं । उनके द्वारा उत्पन्न विद्युत्-क्षेत्र का परिमाण और दिशा का परिकलन मूल बिन्दु (0, 0) पर कीजिए ।

अथवा

(a) एकसमान आवेशित लम्बे सीधे तार,

(b) एकसमान आवेशित अनन्त समतल चादर

के कारण उत्पन्न विद्युत्-क्षेत्र का परिकलन करने के लिए गाउस नियम का अनुप्रयोग करते समय उपयोग किए जाने वाले उपयुक्त गाउसीय-पृष्ठ खींचिए ।

13. Write two characteristics of equipotential surfaces. Draw the equipotential surfaces due to an electric dipole.

समविभव पृष्ठ की दो विशेषताएँ लिखिए । एक वैद्युत द्विध्रुव के लिए समविभव पृष्ठ खींचिए ।

14. Identify the different types of e.m. radiations, which are used

(a) to kill germs,

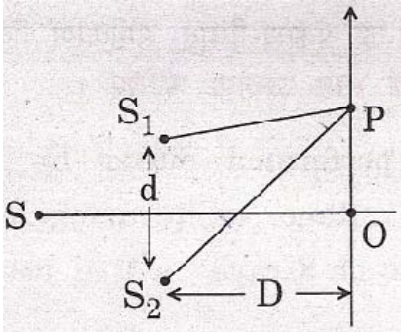
(b) for physical therapy.

उन विद्युत्-चुम्बकीय विकिरणों के विभिन्न प्रकारों को पहचानिए जिनका उपयोग

(a) रोगाणुओं को नष्ट करने में किया जाता है,

(b) काय चिकित्सा (physical therapy) में किया जाता है ।

igure shows a 'double slit experimental set-up', for observing
erence fringes due to different component colours of white light.
would be the predominant colour of the fringes observed at the



O, the central point

P, where $S_2P - S_1P = \frac{\lambda_b}{2}$? 2

λ_b is the wavelength of the blue colour)

16. Write Einstein's photoelectric equation relating the maximum kinetic energy of the emitted electron to the frequency of the radiation incident on a photosensitive surface. State clearly the basic elementary process involved in photoelectric effect.

किसी प्रकाश-सुग्राही पृष्ठ पर आपतित विकिरणों की आवृत्ति तथा उत्सर्जित इलेक्ट्रॉनों की अधिकतम गतिज ऊर्जा में संबंध दर्शाने वाला आइंस्टाइन का प्रकाश-विद्युत् समीकरण लिखिए । प्रकाश-विद्युत् प्रभाव में सम्मिलित मूल प्रारम्भिक प्रक्रिया का स्पष्ट उल्लेख कीजिए ।

17. Crystal diffraction experiments can be performed either by using electrons accelerated through appropriate voltage, or by using X-rays. If the wavelength of these probes (electrons or X-rays) is 1 Å, estimate which of the two has greater energy.

क्रिस्टल विवर्तन प्रयोग को या तो उपयुक्त वोल्टता तक त्वरित इलेक्ट्रॉनों अथवा X-किरणों का उपयोग करके किया जा सकता है । यदि इन परीक्षित्रों (इलेक्ट्रॉनों अथवा X-किरणों) की तरंगदैर्घ्य 1 Å है, तो आकलन कीजिए कि इनमें से किसकी ऊर्जा अधिक है ।

18. "A communication satellite is essentially a repeater station in space." Justify this statement by analyzing the function of a repeater.

"संचार उपग्रह तत्त्वतः अन्तरिक्ष में एक परावर्तक स्टेशन है ।" किसी परावर्तक के कार्य का विश्लेषण करते हुए इस कथन की पुष्टि कीजिए ।

19. Three resistors, R_1, R_2 and R_3 are connected in parallel, across a source of emf E and negligible internal resistance.

Obtain a formula for the equivalent resistance of this combination. Also write expressions for the current through each of the three resistors.

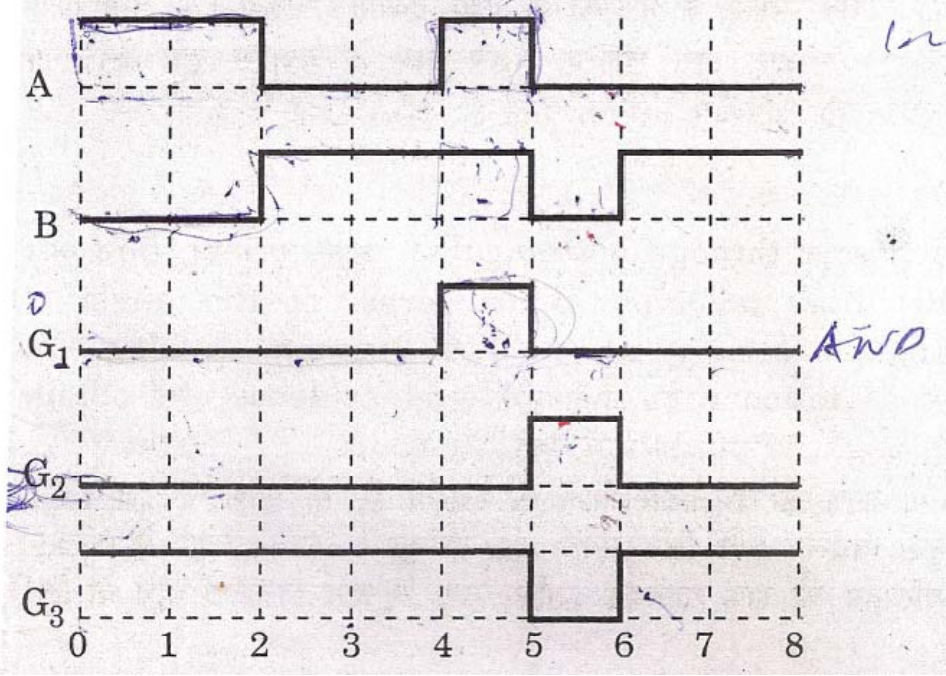
तीन प्रतिरोधक R_1, R_2 तथा R_3 पार्श्वक्रम में किसी उपेक्षणीय आन्तरिक प्रतिरोध तथा विद्युत्-वाहक बल E के किसी स्रोत से संयोजित हैं ।

इस संयोजन के तुल्य प्रतिरोध के लिए सूत्र व्युत्पन्न कीजिए । तीनों प्रतिरोधकों से प्रवाहित धाराओं के लिए व्यंजक भी लिखिए ।

20. State, with the help of a circuit diagram, the working principle of a potentiometer. Describe briefly the method used for determining the internal resistance of a cell. Draw also the necessary circuit for it.

The inputs, A and B, shown here, are used as the inputs for t different gates, G_1, G_2 and G_3, one by one. The outputs, obtained ir three cases, have the forms shown.

Identify the three gates and write their symbols.



22. Draw a plot of binding energy per nucleon (BE/A) vs. mass number (A) for a large number of nuclei lying between $2 \leq A \leq 240$. Using this graph explain clearly how the energy is released in both the processes of nuclear fission and fusion.

$2 \leq A \leq 240$ के बीच की अधिक संख्या के नाभिकों के लिए द्रव्यमान संख्या (A) तथा बंधन ऊर्जा प्रति न्यूक्लिऑन (BE/A) के बीच ग्राफ खींचिए । इस ग्राफ के उपयोग द्वारा यह स्पष्ट कीजिए कि, नाभिकीय विखण्डन तथा नाभिकीय संलयन, दोनों ही अभिक्रियाओं में ऊर्जा किस प्रकार मुक्त होती है ।

23. When a ray of light passes through a triangular glass prism, find out the relation for the total deviation, δ, in terms of the angle of incidence, i, and angle of emergence e. Plot a graph showing the variation of angle of deviation with the angle of incidence and obtain the condition for the angle of minimum deviation.

जब कोई प्रकाश किरण किसी काँच के त्रिभुजाकार प्रिज़्म से गुज़रती है, तो आपतन कोण i तथा निर्गत कोण e के पदों में कुल विचलन δ के लिए संबंध ज्ञात कीजिए । आपतन कोण में परिवर्तन के साथ विचलन कोण में परिवर्तन को ग्राफ खींचकर दर्शाइए तथा न्यूनतम विचलन कोण के लिए प्रतिबन्ध प्राप्त कीजिए ।

24. State the principle of a transistor amplifier with positive feedback working as an oscillator. Draw a circuit diagram showing how the feedback can be achieved by induction coupling (through mutual inductance) to get a self-sustained oscillator. Explain briefly its working.

OR

How is a zener diode fabricated so as to make it a special purpose semiconductor diode ? Draw the circuit diagram of a zener diode as a voltage regulator and explain its working.

25. The energy of the electron, in the ground state of hydrogen, is −13·6 eV. Calculate the energy of the photon that would be emitted if the electron were to make a transition corresponding to the emission of the

(i) first line of the Lyman series

(ii) second line of the Balmer series

of the hydrogen spectrum. 3

हाइड्रोजन की निम्नतम अवस्था में इलेक्ट्रॉन की ऊर्जा −13·6 eV है । हाइड्रोजन स्पेक्ट्रम में फोटॉन की वह ऊर्जा परिकलित कीजिए जो (i) लाइमन श्रेणी की प्रथम रेखा, (ii) बामर श्रेणी की द्वितीय रेखा के लिए इलेक्ट्रॉन के संक्रमण द्वारा उत्सर्जित ऊर्जा के तदनुरूपी होती है ।

26. Light incident at an angle of incidence of 45°, in a certain medium, goes grazing along its surface of separation from air, after refraction. What is

(a) the velocity of light in this medium ?

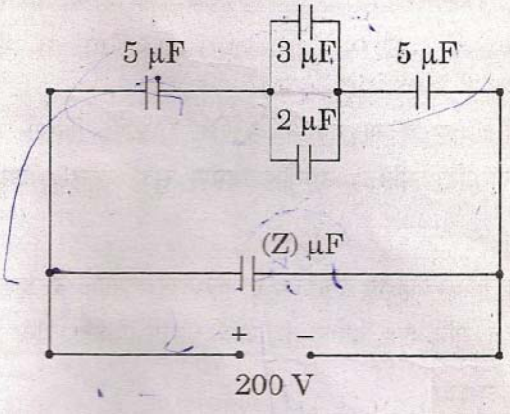
(b) the angle of incidence, at which light, from air, must be incident on this medium, so that the refracted ray is normal to the reflected ray ? Also name the special property exhibited by light for this angle of incidence. 3

किसी माध्यम में 45° के आपतन कोण पर कोई प्रकाश अपवर्तन के पश्चात् वायु से पृथकन करने वाले पृष्ठ के अनुदिश संस्पर्श करते हुए गमन करती है ।

(a) इस माध्यम में प्रकाश का वेग क्या है ?

(b) उस आपतन कोण का क्या मान है जिस पर वायु से इस माध्यम में आपतन करने पर अपवर्तित किरण परावर्तित किरण के अभिलम्बवत् होती है ? इस आपतन कोण पर प्रकाश द्वारा प्रदर्शित विशिष्ट गुण का नाम भी लिखिए ।

27. A system of capacitors, connected as shown, has a total energy of 160 mJ stored in it. Obtain the value of the equivalent capacitance of this system and the value of Z. 3



28. (a) Draw the ray diagram for the formation of image of an object b a convex mirror and use it (along with the sign convention) t derive the 'mirror formula'.

(b) Use the mirror formula to show that for an object, kept betwee the pole and focus of a concave mirror, the image appears to b formed behind the mirror.

OR

Draw a labelled ray diagram for the formation of image by compound microscope. Obtain the expression for the tota magnification when the image is formed at infinity.

In the case of a compound microscope, give reasons to explain th following :

(i) Both the objective and the eyepiece have short focal lengths.

(ii) Our eyes should be positioned not on the eyepiece but a sho distance away from it for best viewing.

29. Write an expression for the force experienced by a charge q, moving with a velocity $\vec{v}$, in a magnetic field $\vec{B}$. Use this expression to

(i) define the unit of magnetic field.

(ii) obtain an expression for the force experienced by a current carrying wire in a magnetic field.

Using the result obtained in (ii) above, along with the (well-known) expression for the magnetic field due to a long straight current carrying wire, deduce the expression for the force between two long straight parallel wires carrying currents I_1 and I_2 in the same direction. 5

OR

Deduce the expression for the torque acting on a rectangular current loop placed in a uniform magnetic field. If $\vec{m}$ represents the magnetic moment of the current loop and $\vec{B}$ the magnetic field, show that the torque $\vec{\tau}$ can be expressed as

$$\vec{\tau} = \vec{m} \times \vec{B},$$

indicating clearly the direction in which the torque acts with respect to the directions of $\vec{m}$ and $\vec{B}$.

Explain briefly how the working of a moving coil galvanometer is based on this principle. 5

30. An a.c. source of emf $E = E_0 \sin \omega t$ is connected across a series combination of an inductor L, a capacitor C and a resistor R. Obtain an expression for the equivalent impedance (Z) of the circuit and hence find the value of ω, for the a.c. source, for which Z = R.

Show that the phase angle, ϕ, (between the current flowing in this circuit and the voltage applied to it) can be obtained through the relation

$$\phi = \tan^{-1}\left[\frac{\text{Reactive Impedance}}{\text{Resistance}}\right].$$ 5

OR

Explain, with the help of a necessary diagram, the working of a step-up transformer and obtain the expression for the transformer equation

$$\frac{i_p}{i_s} = \frac{v_s}{v_p} = \frac{N_s}{N_p}$$

where the symbols have their usual meaning.

What are the two main assumptions made to derive the above relations ?

Mention two important reasons due to which energy losses occur in actual transformers. 5