CHANANA INSTITUTE OF PHYSICS

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SAMPLE PRE BOARD

TIME: 3HRS **M.M. =70**

General Instructions:

- All questions are compulsory.
- There is no overall choice. However, an internal choice has been provided in all questions of five marks. You have to attempt only one of the choices in such questions.
- Question numbers 1 to 5 are very short answer type questions, carrying one mark each.
- Questions numbers 6 to 10 are short answer type questions carrying two marks each.
- Question numbers 11 to 22 are also short answer type questions, carrying 3 marks each.
- Question number 23 is value based type question, carrying four marks.
- Question numbers 24 to 26 are long answer type questions, carrying five marks each.
- Use of calculators is not permitted. However, you may use log tables, if necessary. You may use the following physical constants wherever necessary.

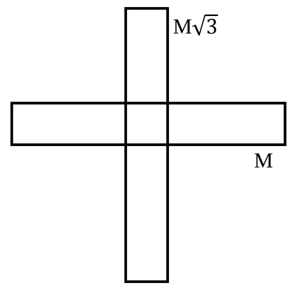
$c = 3 \times 10^8\ ms^{-1}$
$h = 6.6 \times 10^{-34}\ Js$
$e = 1.6 \times 10^{-19} C$
$\mu_o = 4\pi \times 10^{-7}\ TmA^{-1}$
$1/4\pi\varepsilon_o = 9 \times 10^9\ N\ m^2C^{-2}$
Avogadro number $N_A = 6.023 \times 10^{23}\ mol^{-1}$
Mass of the neutron $= 1.675 \times 10^{-27}$ kg
Boltzmann constant, $k = 1.38 \times 10^{23}\ J\ K^{-1}$

1. Two circular loop of radii r and 2r, have currents l and $\frac{l}{2}$ flowing through them in clockwise and anticlockwise sense respectively. If their equivalent magnetic moments are $\vec{M_1}$ and $\vec{M_2}$ respectively, state the relation between $\vec{M_1}$ and $\vec{M_2}$.
2. Let the wavelength of the electromagnetic wave used quite often for
(i) Killing germs in household water purifiers (ii) Remote sensing
(iii) Treatment of cancer be labelled as $\square_1$, $\square_2$ and $\square_3$. Arrange $\square_1$, $\square_2$ and $\square_3$ in increasing order.
3. The maximum velocity of electrons, emitted from a metal surface of negligible work function is 'V' when frequency of light falling on it is 'v'. What will be the maximum velocity when the incident light frequency is made '4v'?
4. A capacitor is being charged by connecting it to a battery. Write the expression for current which flows between the plates during the charging of capacitor.
5. Name the types of the communications that uses carrier signals having frequencies in the range (a) 88-108 MHz (b) 896-901 MHz.

6. A capacitor is charged with a battery and then its plate separation is increased without disconnecting the battery. What will be the change in
(a) Charge stored in the capacitor?
(b) Energy stored in the capacitor?
(c) Potential difference across the plates of the capacitor?
(d) Electric field between the plates of the capacitor?

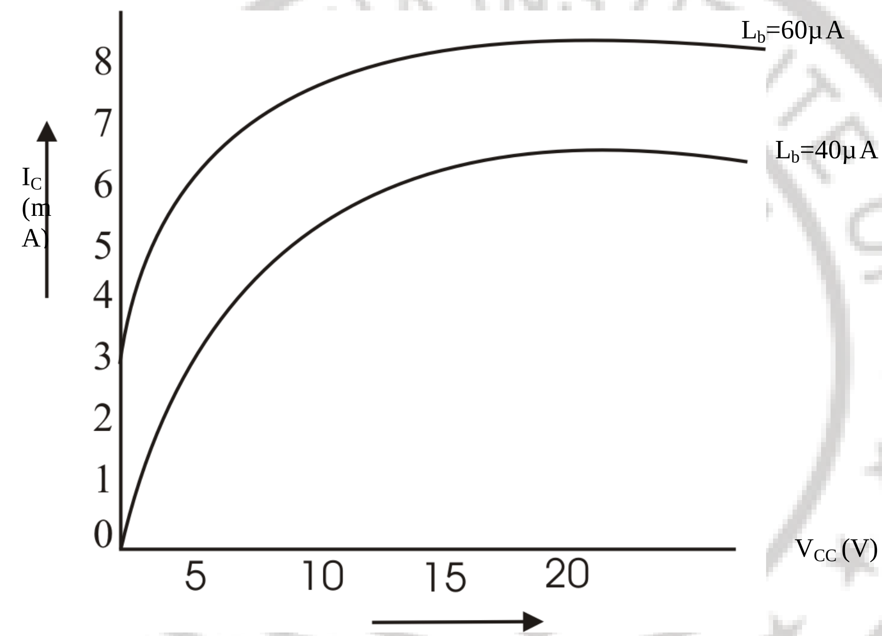
7. A battery of emf E and internal resistance r is connected to a variable resistor R. Draw a graph to show the variation of terminal potential difference with variation in R. Can TPD of a cell be greater than its emf?
Or
Draw the current versus potential difference characteristic for a cell. How can the internal resistance of the cell be determined from this graph?

8. Two magnets of magnetic moments M and $M\sqrt{3}$ are joined to form a cross. The combination is suspended in a uniform magnetic field B. the magnetic moment M now makes an angle of 0 with the field direction. Find the value of angel θ.



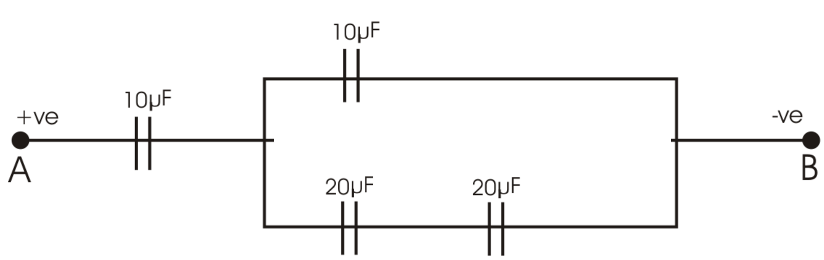
9. A plane electromagnetic wave, of angular frequency ω, is propagating with velocity c along the Z-axis. Write the vector equations, of oscillating electric and magnetic fields, and show these fields diagrammatically.

10. A certain n-p-n transistor has the common emitter output characteristics as shown.



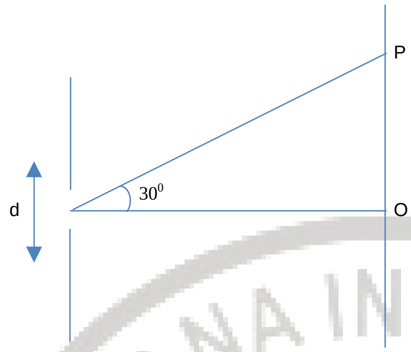
(a) Find the emitter current at V_{CC}=10 and I_b=60μA.
(b) Find β at this point.

11. State Gauss's Theorem. Using Gauss's theorem establish that the magnitude of electric field intensity at a point due to an infinite plane sheet with uniform charge density σ is independent of the distance of the field point.
12. Figure shows the network of capacitors.



For supply V_{AB}=300 V, determine the charge and voltage across each capacitor.

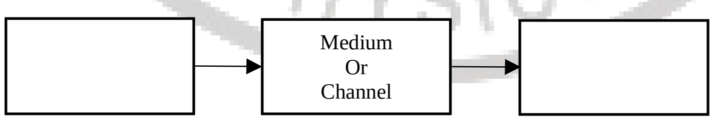
13. State Ampere's circuital law. Using it obtain the expression for the magnetic field due to a long solenoid at a point inside the solenoid on its axis.
14. A galvanometer has a current range 0-15 mA and voltage range 0-750mV. How will you convert it into an ammeter of range 0-25 Ampere?
15. Define mutual inductance. Obtain an expression for the mutual inductance between a long straight wire and a square loop of side 'a' lie in the same plane X-O-Y.
16. A slit of width 'd' is illuminated by white light. For what value 'd' is the first minimum, for red light of λ=650nm, located at point P? For what value of the wavelength of light will the first diffraction maxima also fall at P?



17. Give reason for each of the following observations:
(i) The resultant intensity at any point on the screen varies between zero and four times the intensity, due to one slit, in young's double slit experiment.
(ii) A few coloured fringes, around a central while region, are observed on the screen, when the source of monochromatic light is replaced by white light in young's double slit experiment.
(iii)The intensity of light transmitted by a Polaroid is half the intensity of the light incident on it.

18. (i) The image of a bulb is to be obtained on a wall 5m away. What is the maximum focal length of the convex lens required?
(ii) A plane mirror is kept in contact with a convex lens of focal length 20cm. Where should an object be kept so that there is no parallax between image and the object. Justify your answer.
19. What reasoning led de-Broglie to put forward the concept of matter waves? The wavelength, λ, of photon, and the de-Broglie wavelength associated with a particle of mass 'm', has the same value, say λ, show that the energy of photon is $\frac{2\lambda mc}{h}$ times the kinetic energy of the particle.
20. The ground state energy of hydrogen atom is -13.6eV.
(i) What are the potential and kinetic energy of an electron in the 3^{rd} excited state?
(ii) If the electron jumps to the ground state from the third excited state, calculate the frequency if photon emitted.

21. If nuclei, with lower binding energy per nucleon, transform to nuclei with greater binding energy per nucleon, would the reaction be exothermic or endothermic? Justify your answer. What is the energy of muonic H atom in ground state. Mass of muon is 207 times mass of electron and it revolves around a proton.
22. Complete the following block diagram depicting the essential elements of a basic communication system.

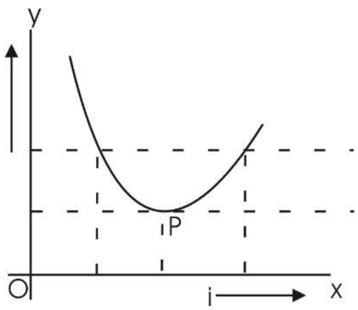


Name the two basic modes of communication. Which of these modes is used for telephonic communication?

Or

Is it necessary for the transmitting antenna and the receiving antenna to be of the same height for line of sight communication? Find an expression for maximum line of sight distance d_m between these two antennas of height h_T and h_g.
23. An illiterate rich man of a village, somewhere listened about the saving of electric power. He decided to use fluorescent tubes of 40 W in place of electric bulbs of 100 W. he purchased fluorescent tubes and connected the tubes directly with ac mains. The fluorescent tubes did not glow. The rich man asked Mr. Ramesh, an electrician of the same village about the reason that the tube light are not glowing. Mr. Ramesh used the choke coil and all the tubes start glowing. Rich man became very happy.
(i)What according to you, are the values displayed by Mr. Ramesh?
(ii)What is a choke coil?
(iii)Why is choke coil needed in the use of fluorescent tube with an ac mains?
(iv)Why can we not use an ordinary resistor instead of the choke coil?

24. A plot, between the angle of deviation(δ) and angle of incidence (i), for a triangular prism is shown below. Explain why any given value of 'δ' corresponds to two values of angle of incidence. State the significance of point 'P' on the graph. Use this information to derive an expression for refractive index of the material of the prism.

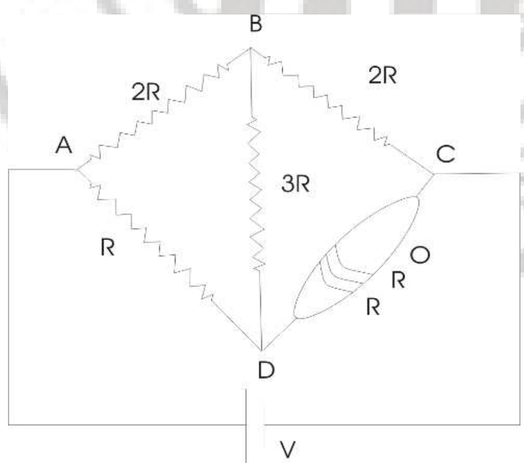


A thin lens, made of a material of refractive index μ, has a focal length 'f. if the lens is placed in a transparent medium of refractive index 'n'(n<μ),obtain an expression for the change in the focal length of the lens. Use the result to show that the focal length of a lens of the glass($\mu = \mu_g$) becomes $\frac{\mu_w\,(\mu_g - 1)}{(\mu_g - \mu_w)}$ times its focal length in air, when it us placed in water ($\mu = \mu_w$). What happened when n>μ? Explain using appropriate ray diagram.

25. Is current density, a vector or a scalar quantity? Deduce the relation between current density and potential difference across a current carrying conductor of length l, area of cross-section A, and number density of free electrons n. How does the current density, in a conductor vary with
(a) Increase in potential gradient?
(b) Increase in temperature?
(c) Increase in length?
(d) Increase in area of cross-section?
(Assume that the other factors remain constant in each case.)

Or

(a) State the principle of a potentiometer. What happens to balancing length in potentiometer if
(i) series resistance with galvanometer is increased, (ii) shunt resistance across secondary cell is decreased.
(b) Write the condition of balance in a Wheatstone bridge. In the given Wheatstone bridge the current in the resistor 3R, is zero. Find the value of R, if the carbon resistor, connected in one arm of the bridge, has the colour sequence of red, red and orange.



The resistance, of BC and CD arms, are now interchanged and another carbon resistance is connected in place of R so that the current through the arm BD is again zero. Write the sequence of colour bands of this carbon resistor. Also, find the value of current through it.

26. Draw a circuit diagram to show how a photodiode is biased. Draw its characteristics curve for two different illumination intensities.

A photodiode is fabricated from a semiconductor with band gap of 2.8eV. Can it detect a wavelength of 6000 nm? Justify.

Or

Why the base region of a transistor is usually made thin? The input resistance of a silicon transistor is 665Ω. Its base current is changed by 15μA, which results in change of collector current by 2 mA. This transistor is used as a common emitter amplifier with a load resistance of 5Ω.

Calculate

(i) Current gain β_{ac}

(ii) Trans conductance g_m

(iii) Voltage gain A_v of the amplifier