

Govind Vidyalaya, Tamulia
XII – PHYSICS

Time: Three Hours

Maximum Marks: 70

General Instructions

- (a) All questions are compulsory.
- (b) There are 30 questions in total. Questions 1 to 8 carry one mark each, questions 9 to 18 carry two marks each, questions 19 to 27 carry three marks each, and questions 28 to 30 carry five marks each.
- (c) 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. You have to attempt only one of the given choices in such questions.
- (d) Use of calculator is not permitted.
- (e) You may use the following physical constants wherever necessary.

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

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$h = 6.6 \times 10^{-34} \text{ JS}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ NA}^{-2}$$

$$k_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

$$N_A = 6.023 \times 10^{23} / \text{mole}$$

$$m_n = 1.6 \times 10^{-27} \text{ kg}$$

1. Two identical charged particles moving with same speed enter a region of uniform magnetic field. If one of these enters normal to the field direction and the other enters along a direction at 30° with the field, what would be the ratio of their angular frequencies?
2. Why does a metallic piece become very hot when it is surrounded by a coil carrying high frequency alternating current?
3. How is a sample of an n-type semiconductor electrically neutral though it has an excess of negative charge carriers?
4. Name the characteristics of electromagnetic waves that
 - (i) increases
 - (ii) remains constantin the electromagnetic spectrum as one moves from radiowave region towards ultraviolet region.

5. How would the angular separation of interference fringes in young's double slit experiment change when the distance of separation between the slits and the screen is doubled?

6. Calculate the ratio of energies of photons produced due to transition of electron of hydrogen atom from its,

- (i) Second permitted energy level to the first level, and
- (ii) Highest permitted energy level to the second permitted level

7. Give expression for the average value of the a c voltage

$$V = V_0 \sin \omega t$$

over the time interval $t = 0$ and $t = \pi/\omega$

8. How is the band gap, E_g , of a photo diode related to the maximum wavelength, λ_m , that can be detected by it?

9. Keeping the voltage of the the charging source constant, what would be the percentage change in the energy stored in a parallel plate capacitor if the separation between its plates were to be decreased by 10%?

10. Explain how the average velocity of free electrons in a metal at constant temperature, in an electric field, remain constant even though the electrons are being constantly accelerated by this electric field?

11. How is the resolving power of a microscope affected when,

- (i) the wavelength of illuminating radiations is decreased?
- (ii) the diameter of the objective lens is decreased?

Justify your answer.

12. What is the basic difference between the atom or molecule of a diamagnetic and a paramagnetic material? Why are elements with even atomic number more likely to be diamagnetic?

13. Why are infrared radiations referred to as heat waves also? Name the radiations which are next to these radiations in electromagnetic spectrum having

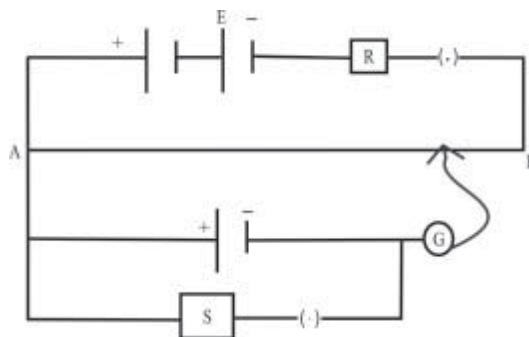
- (i) Shorter wavelength.
- (ii) Longer wavelength.

14. The following data was recorded for values of object distance and the corresponding values of image distance in the experiment on study of real image formation by a convex lens of power +5D. One of these observations is incorrect. Identify this observation and give reason for your choice:

S.No.	1	2	3	4	5	6
Object distance(cm)	25	30	35	45	50	55

Image distance(cm)	97	61	37	35	32	30
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15. Two students X and Y perform an experiment on potentiometer separately using the circuit diagram shown here.



Keeping other things unchanged

(i) X increases the value of distance R

(ii) Y decreases the value of resistance S in the set up.

How would these changes affect the position of null point in each case and why?

16. The following table gives the values of work function for a few photo sensitive metals

S.No.	Metal	Work Function (eV)
1.	Na	1.92
2.	K	2.15
3.	Mo	4.17

If each of these metals is exposed to radiations of wavelength 300 nm, which of them will not emit photo electrons and why?

OR

By how much would the stopping potential for a given photosensitive surface go up if the frequency of the incident radiations were to be increased from 4×10^{15} Hz to 8×10^{15} Hz?

Given $h = 6.4 \times 10^{-34}$ J-s, $e = 1.6 \times 10^{-19}$ C and $c = 3 \times 10^8$ $m s^{-1}$

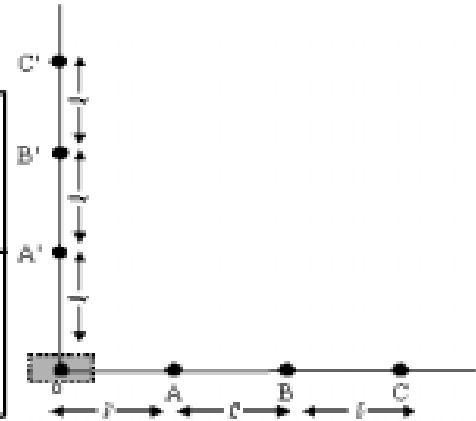
17. Prove that the instantaneous rate of change of the activity of a radioactive substance is inversely proportional to the square of its half life.

18. What does the term LOS communication mean? Name the types of waves that are used for this communication.

Which of the two-height of transmitting antenna and height of receiving antenna - can affect the range over which this mode of communication remains effective?

19. The following data was obtained for the dependence of the magnitude of electric field, with distance, from a reference point O, within the charge distribution in the shaded region.

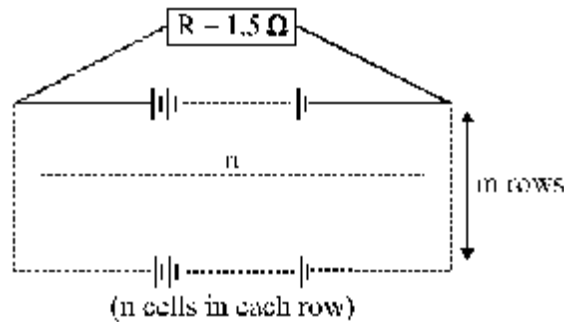
Field Point	A	B	C	A'	B'	C'
Magnitude of electric field	E	E/8	E/27	E/2	E/16	E/64



- (i) Identify the charge distribution and justify your answer.
 (ii) If the potential due to this charge distribution, has a value V at the point A, what is its value at the point?

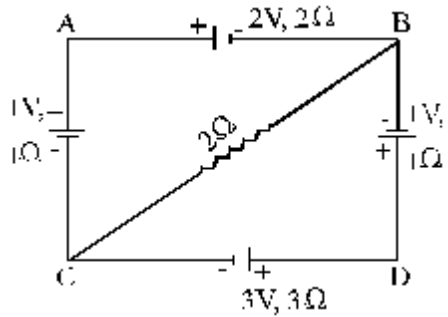
20. A charge Q located at a point \vec{r} is in equilibrium under the combined electric field of three charges Q_1, Q_2, Q_3 . If the charges Q_1, Q_2 are located at points \vec{r}_1 and \vec{r}_2 respectively, find the direction of the force on Q , due to Q_3 in terms of $Q_1, Q_2, \vec{r}_1, \vec{r}_2$, and \vec{r} .

21. 12 cells, each of emf $1.5V$ and internal resistance 0.5Ω , are arranged in m rows each containing n cells connected in series, as shown. Calculate the values of n and m for which this combination would send maximum current through an external resistance of 1.5Ω .



OR

For the circuit shown here, calculate the potential difference between points B and D



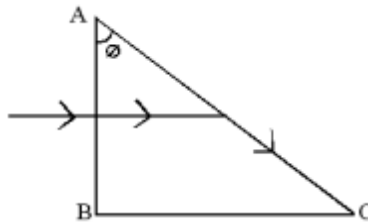
22. A beam of light of wavelength 400 nm is incident normally on a right angled prism as shown. It is observed that the light just grazes along the surface AC after falling on it. Given that the refractive index of the material of the prism varies with the wavelength λ as per the relation

$$\mu_A = 1.2 + \frac{b}{\lambda^2}$$

calculate the value of b and the refractive index of the prism material for a wavelength

$$\lambda = 5000 \text{ \AA}$$

[(Given = $\sin^{-1}(0.625)$)]



23. Three students X, Y, and Z performed an experiment for studying the variation of alternating currents with angular frequency in a series LCR circuit and obtained the graphs shown below. They all used a.c. sources of the same r. m. s. value and inductances of the same value.

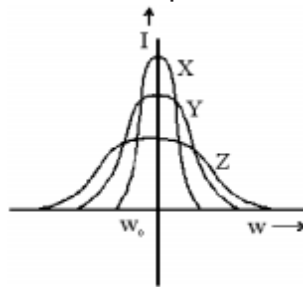
What can we (qualitatively) conclude about the

(i) capacitance value

(ii) resistance values

used by them? In which case will the quality factor be maximum?

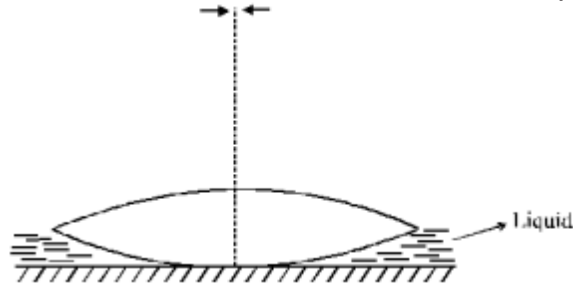
What can we conclude about nature of the impedance of the set up at frequency ω_0 ?



24. An equiconvex lens with radii of curvature of magnitude r each, is put over a liquid layer poured on top of a plane mirror. A small needle, with its tip on the principal axis of

the lens, is moved along the axis until its inverted real image coincides with the needle itself. The distance of the needle from the lens is measured to be 'a'. On removing the liquid layer and repeating the experiment the distance is found to be 'b'.

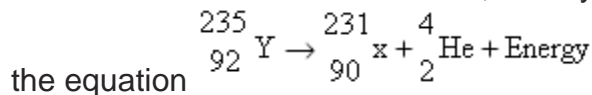
Given that two values of distances measured represent the focal length values in the two cases, obtain a formula for the refractive index of the liquid.



25. A circular coil having 20 turns, each of radius 8 cm, is rotating about its vertical diameter with an angular speed of 50 radian s^{-1} in a uniform horizontal magnetic field of magnitude 30 mT. Obtain the maximum average and r. m. s. values of the emf induced in the coil.

If the coil forms a closed loop of resistance 10Ω , how much power is dissipated as heat in it?

26. The nucleus of an atom of ${}_{92}^{235}\text{Y}$, initially at rest, decays by emitting an α -particle as per



It is given that the binding energies per nucleon of the parent and the daughter nuclei are 7.8 MeV and 7.835 MeV respectively and that of α -particle is 7.07 MeV/nucleon. Assuming the daughter nucleus to be formed in the unexcited state and neglecting its share in the energy of the reaction, calculate the speed of the emitted α -particle. Take mass of α -particle to be $6.68 \times 10^{-27} \text{ kg}$.

27. Define the term 'modulation index' for an AM wave. What would be the modulation index for an AM wave for which the maximum amplitude is 'a' while the minimum amplitude is 'b' ?

28. Two circular coils X and Y having radii R and R/2 respectively are placed in horizontal plane with their centres coinciding with each other. Coil X has a current I flowing through it in the clockwise sense. What must be the current in coil Y to make the total magnetic field at the common centre of the two coils, zero?

With the same currents flowing in the two coils, if the coil Y is now lifted vertically upwards through a distance R, what would be the net magnetic field at the centre of coil Y?

OR

A straight thick long wire of uniform cross section of radius 'a' is carrying a steady current I. Use Ampere's circuital law to obtain a relation showing the variation of the magnetic field (B_r) inside and outside the wire with distance r, ($r \leq a$) and ($r > a$) of the field point from the centre of its cross section. Plot a graph showing the nature of this variation.

Calculate the ratio of magnetic field at a point $a/2$ above the surface of the wire to that at a point $a/2$ below its surface. What is the maximum value of the field of this wire?

29. State the principle which helps us to determine the shape of the wavefront at a later time from its given shape at any time. Apply this principle to

(i) Show that a spherical/ plane wavefront continues to propagate forward as a spherical/plane wave front.

(ii) Derive Snell's law of refraction by drawing the refracted wavefront corresponding to a plane

wavefront incident on the boundary separating a rarer medium from a denser medium.

OR

What do we understand by 'polarization' of a wave? How does this phenomenon help us to decide whether a given wave is transverse or longitudinal in nature?

Light from an ordinary source (say a sodium lamp) is passed through a polaroid sheet P_1 . The transmitted light is then made to pass through a second polaroid sheet P_2 which can be rotated so that the angle (θ) between the two polaroid sheets varies from 0° to 90° . Show graphically the variation of the intensity of light, transmitted by P_1 and P_2 , as a function of the angle θ . Take the incident beam intensity as I_0 . Why does the light from a clear blue portion of the sky, show a rise and fall of intensity when viewed through a polaroid which is rotated?

30. A student has to study the input and output characteristics of a n-p-n silicon transistor in the Common Emitter configuration. What kind of a circuit arrangement should she use for this purpose?

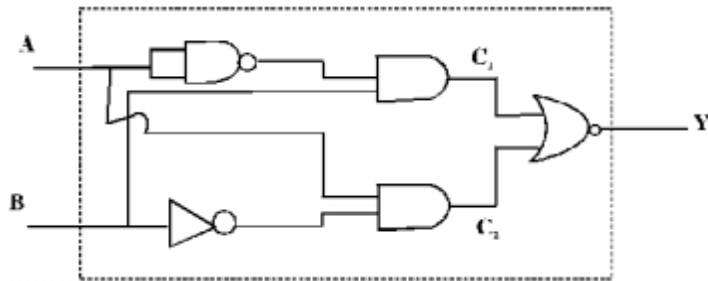
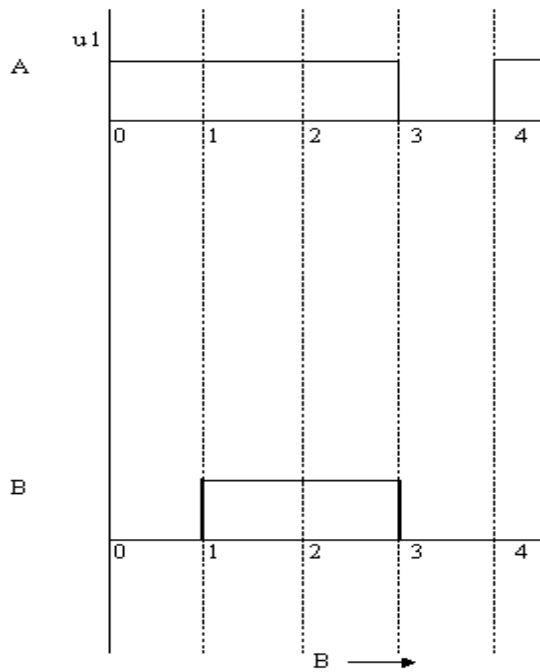
Draw the typical shape of input characteristics likely to be obtained by her. What do we understand by the cut off, active and saturation states of the transistor? In which of these states does the transistor not remain when being used as a switch?

OR

Input signals A and B are applied to the input terminals of the 'dotted box' set-up shown here. Let Y be the final output signal from the box.

Draw the wave forms of the signals labelled as C_1 and C_2 within the box, giving (in brief) the reasons for getting these wave forms. Hence draw the wave form of the final output signal Y. Give reasons for your choice.

What can we state (in words) as the relation between the final output signal Y and the input signals A and B ?



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