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Q1. An electron, an alpha-particle and a proton have the same kinetic energy. Which one of these particles has the largest de-Broglie wavelength?

Answer : We know that de-Broglie wavelength $\lambda = \frac{h}{mv}$ and Kinetic Energy = $K = \frac{1}{2}mv^2$

$$or\ 2mK = m^2v^2\ or\ \sqrt{2mK} = mv\ , \lambda = \frac{\mathrm{h}}{\sqrt{2\mathrm{mK}}}\ \text{i.e.}\ \lambda \propto \frac{1}{\sqrt{\mathrm{m}}}$$

Since mass of alpha > mass of proton > mass of Electron. Electro possess lowest mass therefore de-Broglie wave length from electron has the largest de-Broglie wavelength.

Q2. Why should the material used for making permanent magnets have high coercivity?

Answer: High coercivity means it can withstand high external magnetic and electric field. Therefore high coercivity means magnetization is not destroyed by stray magnetic fields or temperature variations. For making permanent magnet this property is required. So Ferromagnetic materials with high coercivity used for permanent magnet.

Q3. The radioactive isotope D decays according to the sequence

$$\mathrm{D} \xrightarrow{\beta} \mathrm{D_1} \xrightarrow{\alpha - \text{particle}} \mathrm{D_2}$$

If the mass number and atomic number of D_2 are 176 and 71 respectively, what is (I) the mass umber (II) atomic number of D?

Answer: We know that α emission reduces mass by 4 unit and atomic number by 2 unit, β emission only increases atomic number by 1 unit but brings no change in mass. Hence we can write

176-4=X , X=172, 71+1-2=Y, Y= 70

$$^{172}_{70}\mathrm{D} \xrightarrow{^{0}_{-1}\mathrm{e}} {}^{172}_{69}\mathrm{D_1} \xrightarrow{^{4}_{2}\mathrm{He}} {}^{176}_{71}\mathrm{D_2}$$

(I) Mass number of D = 172
(II) Atomic number of D = 70

Q4. What will be the values of input A and B for the Boolean expression $(\overline{\mathrm{A}+\mathrm{B}})(\overline{\mathrm{A}.\mathrm{B}}) = 1$?

Ans. If A=1, B=1 then 0.0=0, if A=1, B=0 then 0.1=0 , similarly A=0,B=1 we get 0.0=0 so not possible

Only If $\mathrm{A} = 0$ and $\mathrm{B} = 0$. $(\overline{0+0})(\overline{0.0}) = (\bar{0}).(\bar{0}) = 1.1 = 1$. Answer is A=B=0

Q5. Why is frequency modulation preferred over amplitude modulation for transmission of music?

Ans. In transmission of music we want to avoid noise, noise can be minimized in frequency modulation hence frequency modulation preferred over amplitude modulation.

Q6. Define electromotive force of a cell.

Answer: The potential difference between two poles of a cell, when no current is drawn from it, is called *electromotive force (emf)* of the cell.

Q7. An electron is projected with a velocity of 10^5 ms^{-1} at right angles to a magnetic field of 0.019 G. Calculate the radius of the circular path described by the electron,

$$\text{if } e = 1.6 \times 10^{-19}\text{C}, m = 9.1 \times 10^{-31}\text{kg}.$$

Answer: Given $v = 10^5 ms^{-1}, e = 1.6 \times 10^{-19}\text{C}, m = 9.1 \times 10^{-31}\text{kg};$

$$B = 0.019\ \text{G} = 0.019 \times 10^{-4}\text{T}$$

We know that centrepetal force is obtained from the force due to magnetic field on moving charge

$$\text{Now } Bev = \frac{mv^2}{r}$$

$$\Rightarrow r = \frac{mv}{Be} = \frac{9.1\times10^{-31}\times10^5}{0.019\times10^{-4}\times1.6\times10^{-19}} = 0.299\ \text{m}$$

Q8. What do you mean by the impedance of LCR circuit?

Answer: The effective resistance offered to the flow of current by the LCR circuit is called its **impedance**.

L-C-R circuit :

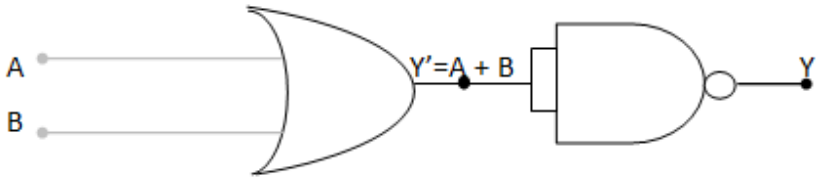
The impedance of the circuit

$$z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega c}\right)^2}$$

Impedance is denoted by $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega c}\right)^2}$

Q9. The output of an OR gate is connected to both the inputs of a NAND gate. Draw the logic circuit of this combination of gates and write its truth table.

Answer: Logic Circuit , here output of OR gate is input for the NAND gate

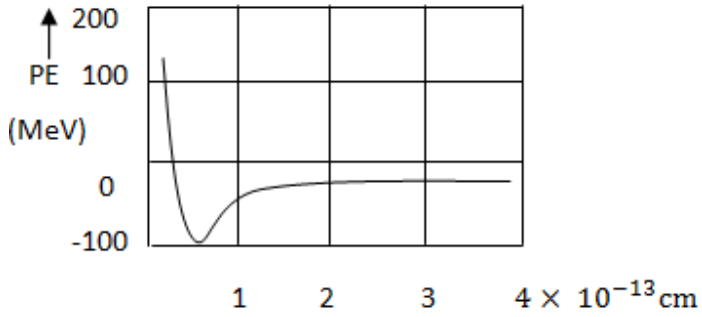


Truth Table for the above Logic Circuit

OR Gate			Input of NAND Gate Y'=C=D		AND Operation	NAND Operation
A	B	Y'=A + B	C	D	C.D	$Y=\overline{(C.D)}$
0	0	0	0	0	0	1
0	1	1	1	1	1	0
1	0	1	1	1	1	0
1	1	1	1	1	1	0

Q10. Draw a plot of potential energy of a pair of nucleons as a function of their separation. What is the significance of negative potential energy in the graph drawn?

Answer: Potential energy (MeV) taken along Y axis and distance of separation of pair of nucleons taken along X-axis, graphical presentation is as shown



The negative potential energy indicates the force between the pair of nucleons is attractive.

Q11. A convex lens of refractive index 1.5 has a focal length of 8 cm in air. Calculate the change in its focal length when it is immersed in water of refractive index 4/3.

Answer: Let fa and fw be the focal length in air and water respectively.

Then $\frac{1}{f_a} = (\mu_g - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

or, $\frac{1}{8} = (1.5 - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

or, $\left[\frac{1}{R_1} - \frac{1}{R_2}\right] = \frac{1}{8\times 0.5} = \frac{1}{4}$

When the lens is immersed in water,

$\frac{1}{f_w} = \left(\frac{\mu_g}{\mu_w} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] = \left(\frac{1.5}{4/3} - 1\right) \times \frac{1}{4}$

$\frac{1}{8} \times \frac{1}{4} = \frac{1}{32} \Longrightarrow \frac{1}{f_w} = \frac{1}{32}$ $\quad \therefore f_w = 32$ cm.

Q12. Distinguish between the terms 'average value' and 'rms value' of an alternating current. The instantaneous current from an a.c. source is I = 5 sin (314 t) ampere. What are the average and rms values of the current?

Answer: **Average value of AC:** The arithmetic mean of all the instantaneous values of current or emf over the half cycle is known as average value of A.C.

Let $i = i_o \sin \omega t \rightarrow (1)$

The instantaneous value of current at an instant of time t

$$i_{ave} = \frac{1}{T/2}\int_0^{T/2} i dt$$

Putting equation (1): $i_{ave} = \frac{1}{T/2}\int_0^{T/2} i_o \sin \omega t dt$

$$i_{ave} = \frac{2i_o}{T}\left[\frac{-\cos \omega t}{\omega}\right]_0^{T/2}$$

$$i_{ave} = -\frac{2}{T}\frac{i_o}{\frac{2\pi}{T}}\left[\cos\frac{2\pi}{T}\frac{T}{2} - \cos 0\right]$$

$$i_{ave} = -\frac{i_o}{\pi}[\cos \pi - \cos 0]$$

$$i_{ave} = \frac{2i_o}{\pi} \rightarrow (2)$$

Similarly

$$e_{ave} = \frac{2e_o}{\pi} \rightarrow (3)$$

RMS Value of AC: To get a suitable mean value we square all the instantaneous values for a complete cycle where by all become positive and then are added and the mean is taken. Finally to get rid of square the square root is taken. This value is known as root mean square value.

Let $e = e_o \sin \omega t \rightarrow (1)$

The instataneo us emf i.e. the value of emf at an instant of time t

$$e_{rms} = \sqrt{\frac{1}{T}\int_0^T e^2 dt}$$

$$e_{rms}^2 = \frac{1}{T}\int_0^T e^2 dt$$

$$e_{rms}^2 = \frac{1}{T}\int_0^T e_o^2 \sin^2 \omega t dt$$

$$e_{rms}^2 = \frac{e_o^2}{2T}\int_0^T 2\sin^2 \omega t dt$$

$$e_{rms}^2 = \frac{e_o^2}{2T}\int_0^T (1 - \cos 2\omega t) dt$$

$$e_{rms}^2 = \frac{e_o^2}{2T}\left[\int_0^T dt - \int_0^T (\cos 2\omega t) dt\right]$$

$$e_{rms}^2 = \frac{e_o^2}{2T}\left[T - \frac{1}{2\omega}(\sin 2\omega T - \sin 2\omega.0)\right]$$

Given I = 5 sin (314 t) ampere

$\therefore$ Peak value of current, $I_p = 5A$

$I_{av} = 0.637\, I_p = 0.637 \times 5 = 3.185\ A$

$I_{rms} = 0.707\, I_p = 0.707 \times 5 = 3.535\ A$

13. Write the relation for the force $\vec{F}$ acting on a charge carrier q moving with a velocity $\vec{v}$ through a magnetic field $\vec{B}$ in vector notation. Using this relation, deduce the conditions under which this force will be (I) maximum (II) minimum.

Answer: $\vec{F} = q(\vec{v} \times \vec{B})$

$\therefore F = qvB \sin\theta$

(I) When $\theta = 90^\circ, F = qvB \sin 90^\circ = qvB$ ie., force is maximum. Thus when velocity is at right angle to the direction of magnetic field then force is maximum.

(II) When $\theta = 0^\circ, F = qvB \sin 0^\circ = 0$ ie., force is minimum. Force will be minimum also when v = 0. Thus when the velocity is in parallel to the direction of magnetic field no force acts on the charge carrier i.e. force is minimum.