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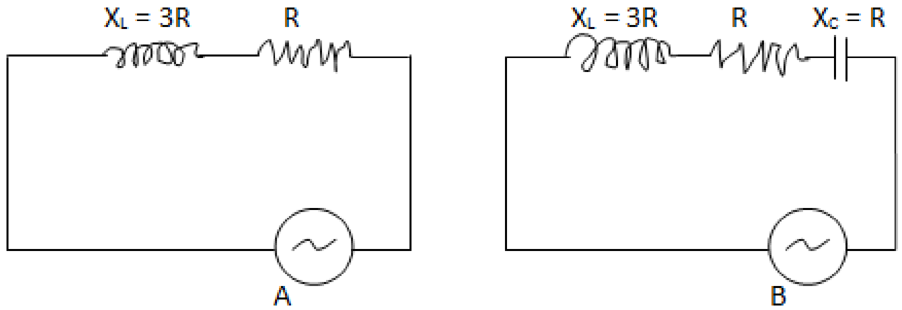
Q21. Given below are two electric circuits A and B



Calculate the ratio of power factor of the circuit B to the power factor of circuit A.

Answer: In LR Circuit A, Impedance $z = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + (\omega L)^2}$ ohm

Power factor of A $= \cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2+X_L{}^2}} = \frac{R}{\sqrt{R^2+9R^2}} = \frac{R}{\sqrt{10}R} = \frac{1}{\sqrt{10}}$

In LCR Circuit B, Impedance Z = $z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega c}\right)^2}$

Power factor of B $= \cos\phi = \frac{R}{\sqrt{R^2+(X_L-X_C)^2}} = \frac{R}{\sqrt{R^2+(3R-R)^2}} = \frac{1}{\sqrt{5}}$

$\frac{\text{Power factor of B}}{\text{Power factor of A}} = \frac{1}{\sqrt{5}} \times \frac{\sqrt{10}}{1} = \sqrt{2}$

Q22. Define the term 'resolving power' of an astronomical telescope. How does it get affected on

(I) Increasing the aperture of the objective lens?
(II) Increasing the wavelength of the light used?
Justify your answer in each case.

Answer: Ability to make us see really small details and see sharp images is resolving power. *The resolving power of an astronomical telescope* is defined as the reciprocal of the smallest angular separation between two point objects whose images can just be resolved by the telescope.

Resolving power depends on Diameter (D) and Wavelength(λ)

$$\text{Resolving Power} = \frac{D}{1.22\lambda}$$

(I) Since resolving power is proportional to Diameter($\propto D$),when the aperture of the objective lens is increased, the resolving power also increases as diameter in cases.

(II) Since resolving power is inversely proportional to wavelength ($\propto \frac{1}{\lambda}$), hence if the wavelength of the light is increased, the resolving power decreases.

Q23. Write any four characteristics of electromagnetic waves. Give two uses each of (I) Radio-waves (II) Micro-waves.

Answer: *Characteristics of electromagnetic waves:*

1. The oscillations of electric ($\vec{E}$) and magnetic ($\vec{B}$) field vectors are perpendicular to each other and are in same phase, these to fields are perpendicular to the direction of propagation,hence transverse in nature.
2. Changes in electric and magnetic fields occurs at the same time and place ,hence are in phase.
3. EM waves do not require any material medium for their propagation it can pass through vacuum with a speed $c = 3 \times 10^8 \mathrm{ms}^{-1}$
4. Incident electromagnetic wave exhibits phenomenon like reflection,refraction, diffraction, interference and polarization.

I. **Use of Radio waves are :**
   1. For Television program transmission
   2. For Radio Program transmission(Television uses higher frequencies than radio)

II. **Use of Microwaves are :**
   1. For cooking purpose in microwave ovens
   2. Satellite television programs , mobile phones ,In radar systems

Q24. In a plot of photoelectric current versus anode potential, how does

(I) The saturation current vary with anode potential for incident radiations of different frequencies but same intensity?
(II) The stopping potential vary for incident radiations of different intensities but same frequency?
(III) Photoelectric current vary for different intensities but same frequency of incident radiations? Justify your answer in each case.

Answer:

(I) When intensity remains same, saturation current is independent of frequencies. It does not change with the increase in anode potential.

(II) If frequency remains same, stopping potential is independent of intensities. Since stopping potential depends on frequency and not on the intensity of incident radiation.

(III) Photoelectric current increases linearly with the intensity of incident radiation of same frequency.

Q25. Calculate the amount of energy released during the $\alpha -$ decay of $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$

[Given : 1. atomic mass of $^{238}_{92}U = 238.05079$ u

2. atomic mass of $^{234}_{90}Th = 234.04363$ u

3. atomic mass of $^{4}_{2}He = 4.00260$ u

$1u = 931.5$ MeV/e^2]

Is this decay spontaneous? Give reason.

Answer: Difference in mass will be converted to energy, 1 amu gives 931.5 MeV energy.

The energy released in the $\alpha -$ decay is

$\Delta E = [m(^{238}_{92}U) - m(^{234}_{90}Th) - m(^{4}_{2}He)]c^2$

$= [238.05079 - 234.04363 - 4.00260] \times 931.5$ MeV

$= 0.00456 \times 931.5 = 4.25$ Me V

Spontaneous decay depends on ΔE value, since ΔE is positive, the decay process is spontaneous.

Q26. What is a digital signal? Write two advantages of digital communication. Give any one difference between Fax and E-mail systems of communication.

Answer: A digital signal refers to an electrical signal that is converted into a pattern of bits. Unlike an analog signal, which is a continuous signal that contains time-varying quantities, a digital signal has a discrete value at each sampling point. Hence current or voltage take only two discrete values 0 and 1 in digital signal.

Advantages of digital communication:

(I) Digital signals can convey information with greater noise immunity, because each information component (byte etc) is determined by the presence or absence of a data bit (0 or one) This mode of communication is more reliable.

(II) Enables transmission of signals over a long distance and Its transmission needs simple technique.

We get a hard copy as printout at recipient's terminal in fax communication where as we get a soft copy at the recipient's terminal in email communication.