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PHYSICS - Optional

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Electromagnetic Waves & Blackbody Radiation 2015 - 2019



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UPSC – PHYSICS Optional – 2015 Questions

1. Derive the equation that represents Poynting's theorem. What is its physical significance? [20M]
2. A plane electromagnetic wave propagating along $+\hat{z}$ direction is incident normally on the boundary at $z = 0$ between medium A ($z < 0$) and medium B ($z > 0$). Determine the reflection coefficient and transmission coefficient for the wave. [20M]
3. Using Planck's radiation law, deduce Wien's displacement law. How does this law enable one to estimate the surface temperature of the sun or a star? [15M]

UPSC – PHYSICS Optional – 2016 Questions

1. In free space, the electric field of electromagnetic wave is given as $\vec{E}(x, t) = 120 \cos(\omega t - kx)\hat{y}$ V/m. Find the average power crossing a circular area of radius one metre in the yz -plane. [10M]
2. The spectral energy curve of the moon shows maxima at 470 nm and 14 μm . What inference can you draw from this data? Also calculate the energy density and radiation pressure in both cases. Given, Wien's constant $b = 2.892 \times 10^{-3}$ m K, Stefan's constant $\sigma = 5.67 \times 10^{-8}$ Jm⁻²s⁻¹K⁻⁴ and speed of light $c = 3 \times 10^8$ ms⁻¹ [10M]
3. Briefly explain Plank's law of blackbody radiation. Show that Plank's law reduces to Wien's law and Rayleigh-Jeans law at lower and higher wavelength limits respectively. [20M]

UPSC – PHYSICS Optional – 2018 Questions

1. Define a plane electromagnetic wave. A plane polarized wave is incident on the interface between two dielectric media. Obtain expressions for the amplitudes of the reflected and transmitted waves when the incident wave is polarized with its electric field E vector perpendicular to the plane of incidence. Discuss the phase relationships of the reflected and transmitted waves with respect to the incident wave. [20M]
2. What are the limitations of Rayleigh-Jeans law in explaining the spectrum of radiations from a blackbody? Explain how these limitations were overcome in Planck's radiation law [10M]
3. Deduce Wien's displacement law from Planck's radiation law. [10M]

UPSC – PHYSICS Optional – 2019 Questions

1. Discuss in brief the ultraviolet catastrophe. How did Planck solve this problem? [10M]

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