## physicshelpline

Q1- How much time is required for a radio signal to travel from Earth to a space station on Mars if the planet Mars is $7.83 \times 10^{7} \mathrm{~km}$ from Earth?

The radio wave are electromagnetic waves like light and as all electromagnetic waves travel with equal speed, $3 * 10^{8} \mathrm{~m} / \mathrm{s}$ in vacuum (or air), so as the radio waves and hence

Time $=$ distance travelled/speed
Or $\quad t=\frac{7.83 * 10^{7} * 10^{3} \mathrm{~m}}{3 * 10^{8} \mathrm{~m} / \mathrm{s}}=261 \mathrm{~s}$

Q2- The speed of light through a transparent substance is $2.00 \times 10^{8} \mathrm{~m} / \mathrm{s}$. What is the index of refraction of the substance?

One definition of the index of the refraction is the ratio of the speed of light in vacuum to the speed of light in substance, hence

$$
\mu=\frac{c_{\text {vacuum }}}{c_{\text {medium }}}=\frac{3^{*} 10^{8}}{2^{*} 10^{8}}=1.5
$$

Q3- A monochromatic light source used in a diffraction experiment has a wavelength of $4.60 \times 10^{-7} \mathrm{~m}$. What is the energy of a photon of this light?

Light is having dual nature. This means that in some situations it behaves like waves (interference) and in some situations it behaves like a particle (photoelectric effect). The particle of light (energy packet) is called photon.
The energy of a photon of light is given by

$$
\begin{equation*}
\mathrm{E}=\mathrm{h}^{*} \mathrm{~V} \tag{1}
\end{equation*}
$$

Here $h$ is Planck's constant and $v$ is the frequency of light.
For any wave the frequency $v$ is related to the wavelength $\lambda$ as

$$
v=\frac{c}{\lambda}
$$

Here $c$ is the speed of wave. Substituting in equation (1) we have

$$
\begin{aligned}
E & =h v=\frac{h^{*} c}{\lambda} \\
\text { Or } \quad E & =\frac{\left(6.63^{*} 10^{-34} \mathrm{~J} . \mathrm{s}\right)^{*}\left(3^{*} 10^{8} \mathrm{~m} / \mathrm{s}\right)}{4.60^{*} 10^{-7} \mathrm{~m}}=4.32^{*} 10^{-19} \mathrm{~J}
\end{aligned}
$$

Q4- The wavelength of light from a monochromatic source is measured to be $6.80 \times 10^{-7} \mathrm{~m}$. (a) What is the frequency of this light? (b) What energy does each photon have?
(a) as we know

$$
v=\frac{c}{\lambda}=\frac{3^{*} 10^{8} \mathrm{~m} / \mathrm{s}}{6.80^{*} 10^{-7} \mathrm{~m}}=4.41^{*} 10^{14} \mathrm{~Hz}
$$

(b) The energy of photon

$$
E=h v=6.63^{*} 10^{-34 *} 4.41^{*} 10^{14}=2.93^{*} 10^{-19} \mathrm{~J}
$$

