ADVANCED CHEMISTRY BLOC

Scattering in Colloids and Gas Molecules

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Following the Mount Krakatoa volcanic eruption, in the year 1883, the moon appeared blue and sometimes green for several years. The whole world watched vivid red sunsets for years. Mount Krakatoa, Tambora, Gamkonora of Indonesia and closer areas have displayed some of the massive volcanic eruptions, the world has ever seen. Such eruptions besides causing severe damages to living beings of the archipelago had released several cubic kilometers of rocks and dusts to the atmosphere; the routine optical phenomena occurring in atmosphere was then all set to change.

If a homogeneous solution is observed in the direction of light it appears clear and when observed in a direction right angle to the direction of light, it appears perfectly dark. When light passes through a colloidal solution, scattering takes place. The scattered intensity being highest in the plane at right angle to the path of the light, the path of light becomes visible, particularly when viewed at right angle to the path of the light. This kind of scattering is the Rayleigh scattering. This effect was first noticed by Faraday but detailed studies were made by Tyndall giving it a name Tyndall effect. Scattering also occurs in solution but the amount of scattering is extremely weak. For Tyndall effect to take place, two conditions must be satisfied :

- The diameter of the particles of the dispersed phase must not be much smaller than the wavelength of the light used.
- The refractive indices of the dispersed phase and the dispersion medium must differ considerably.

Do you wonder what will happen when the refractive indices are equal? Insert a glass rod to Canada balsam, a plant product; the rod will disappear as both the glass and the Canada balsam have nearly equal refractive indices.

When the colloidal particles scatter light, they appear as bright self-luminescent particles. Have you ever noticed Sun beam coming from the window in the early morning lights up dust particle brightly? You observe the phenomenon best when you watch at right angle. Next time when you notice it, watch the particles carefully, each one behaves like a tiny bulb but when the same dust particle falls on the floor, it appears pale.

Rayleigh scattering is important in atmosphere, where scattering takes place by gas molecules. For Rayleigh scattering, the scattered energy in any direction is proportional to the inverse fourth power of the radiation wavelength. This shows that when the incident radiation covers a wavelength spectrum, the shorter wavelength radiation will be Rayleigh scattered with a strong preference.

Rayleigh scattering by molecules of the atmosphere accounts for the background of sky being blue and for the sun appearing red at the sunset. The blue portion of the incident sunlight is at the short wavelength end of the visible spectrum. Hence, it undergoes strong Rayleigh scattering into all directions, giving the sky its overall blue background. Without molecular scattering the sky would appear black except for the direct view of the sun. As the sun moves towards setting, the path length for direct radiation through the atmosphere becomes much longer than during middle of the day. In transversing this longer path, proportionately more of the short wavelength part of the visible radiation is scattered away. As a result, at the sunset the sun takes on a red colour. The longer wavelength red rays are able to penetrate the atmosphere along the path to the observer. If many dust particles are present, the sunset may be deep red.

With very different range of size of particles in the atmosphere, unusual scattering effect may be observed. Krakatoa eruption had fed such particles in the atmosphere changing the whole phenomenon of scattering. Similar incidents have also been reported, on September 26, 1950, a blue moon was observed in Europe believed due to finely dispersed smoke particles coming from a forest fire in Canada. A green moon was observed following the El Chichon eruption in Mexico in 1982.

There is another scattering called 'Mie (read as 'me') scattering' observed for particles similar in diameter as the wavelength of the light. Larger particles of the atmosphere are able to scatter light of all wavelengths of white light equally, a phenomenon called Mie scattering. This is the reason why lighter clouds appear white. When you are watching beautiful patches of white clouds against the clear blue sky, besides feeling delighted never forget you are watching Mie scattering and Rayleigh scattering together. If the cloud is thick, light cannot penetrate and it appears black.

(Mount Krakatoa incident had also exemplified optical phenomena "Bishop Ring".)

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I	Column II
1. NEILOVI	(a) A compound which is used to preserve the moisture content of material due to its hygroscopic nature.
2. NGAIMARER	(b) It is a violet variety of quartz. It is impure crystalline silica.
3. UTNOGLEJ	(c) Highly explosive. Formed from ethanoic acid, ethanoic anhydride and nitric acid.
4. TNTAMECHU	(d) It is a mineral silicate of magnesium and iron. The transparent form is used as a gem stone.
5. ITOAIRNLEUT	(e) The property of a crystal of having a different colour depending upon the direction of transmitted light through the crystal.
6. RTTYTSEMA	(f) A chemical which produces malformation, generally in the form of mutations or tumours.
7. SMIROHECOLP	(g) The process of separation of lyophillic sols into too immiscible liquid phases, each of which has a different concentration of the dispersed phase.
8. YNOIETCCL	(h) It is substituted food product like butter which is obtained from vegetable oils (Polyunsaturated fats).
9. VTINOERCCOAA	(i) It is the method of separating a material into fractions of various sizes by allowing it to settle against upward moving stream of fluid, generally air or water.
10. GNTREATOE	(j) It is rubber like material obtained from the tree Dyera costularia.

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