Cosmic Quarry Report

Asteroid Mining

- Due to rapid depletion of natural resources and environmental degradation due to extraction of these resources, scientists are working on sustainable alternative methods.

- Asteroid mining seems rather a very expensive solution, but could actually prove to be very successful, considering the fact that certain asteroids are rich in minerals and could lead to huge profits.

- There are certain challenges that scientists face while developing technology for asteroid mining.
    1. Building a spacecraft and designing its path taking external conditions into consideration, such that the spacecraft lands on target successfully.
    2. Developing mining equipment that can withstand adverse conditions of space, which include solar winds, temperature and vacuum, other tiny objects which may collide with the equipment.
    3. Launching spacecrafts from earth would be an expensive affair. Launching spacecraft from the moon or mars where gravity would be much less is an effective solution once asteroid mining becomes a mainstream business.
    4. Returning the extracted materials back to earth would be challenging as well, and a separate system ensuring the materials don't burn out in the atmosphere itself should be developed.

- Some of the advantages of asteroid mining are listed as follows:
    1. Traditional methods of mining result in deforestation, release of toxic chemicals in the environment, thereby polluting water bodies, air and soil. If executed well, asteroid mining has potential to completely remove environmental impacts of extracting resources from the equation.
    2. There are many illegal practices prevalent in the mining industry, and human trafficking, forced labour, and child labour are its direct consequences. If humans switch to asteroid mining, there would be centralisation of the mining industry and these illegal practices may be reduced to some extent (unless the mining mafia grow strong enough to start sending their own missions on asteroids, which is highly unlikely in real world in near future)
    3. Earth has limited natural resources and even advancements in technology wouldn't help if these resources get depleted. Asteroid mining seems the only viable solution.

4. Asteroid mining would have a great economic impact. Astrophysicist Neil DeGresse Tyson believes the world's first trillionaire would be from the asteroid mining industry. Considering huge investment required and at the same time the huge profits incurred, asteroid mining wouldn't be fiction anymore in the near future.
5. As the asteroid mining programs get executed successfully in the near future, this would open new avenues of space exploration such as space tourism and human settlement. Humans are highly likely to develop technology for the same.

- Asteroid mining seems to be a very efficient and quiet practical solution so far. But there are some probable disadvantages as well:
    1. Asteroid mining may have quite negative impacts on the world economy. As this industry flourishes, there would be a global struggle for power and domination. Meanwhile, the countries such as zimbabwe and congo, whose economy depends entirely on natural resources would face an economic crisis, as no one might be interested in investing in the mining industry on earth.
    2. People whose livelihood depends on mining, which may be considered as low skilled jobs, might be left with no source of income. This would create a situation where 'rich gets richer and poor gets poorer'
    3. Even though outer space is very vast and there is apparently an unlimited supply of minerals, humans are limited by the developments in technology. So, assuming that developing asteroid mining technology would entirely solve mineral scarcity is not true. There is a high possibility that the humans may exhaust resources on nearby asteroids as well, if left unregulated.

Spectroscopy

- Spectroscopy deals with the interaction of radiation and matter. Interestingly, we can deduce the composition of matter with great accuracy solely based on spectroscopic methods.
- There are several applications of spectroscopy:
    1. Medicine : MRI (Magnetic resonance imaging) is nothing but radio frequency spectroscopy of nuclei in magnetic fields.
    2. Cosmology : CMBR (Cosmic microwave background radiation) gives insight to origin of universe
    3. Astronomy : composition of stars, planets and other celestial bodies using optical, radio and x-ray spectroscopy
- Spectroscopic techniques are highly sensitive and in fact frequency is by far the quantity which can be measured with maximum accuracy.
- Spectroscopy is the study of interaction of photons with matter and change in the energy of photons.

Electromagnetic spectroscopy

- Properties of electromagnetic radiation:
    1. Energy propagates through transverse wave moving at speed of light (c = 299,792,458 metres per second) with mutually perpendicular oscillating electric and magnetic fields.
    2. Frequency and wavelength are the measurable properties of the em wave

- Basic properties of atoms:
  The major part of spectroscopy involves quantum mechanical aspects. The energy of atom is determined using quantum mechanical models

- Any physical system has energy levels described using quantum mechanics. The energy of radiation absorbed by the system will be utilised in the transition of the system from one state to another. This is the basic principle on which spectroscopy is based.

- General method of spectroscopy requires three things listed below:
    1. A light source
    2. A disperser to separate light into its constituents
    3. A detector

- Spectroscopy is broadly divided into two types:
    1. Absorption spectroscopy : Radiation is incident on the sample which results in excitation. The spectrum obtained has some missing frequencies which corresponds to the energy of radiation absorbed
    2. Emission spectroscopy : By some means, the sample is excited to a higher state, and as it comes back to a lower state, it emits radiation. This radiation spectrum can be studied to deduce composition of the sample.

- The steps involved in spectroscopic analysis are: irradiating sample with radiation, dispersing obtained spectrum into constituent frequencies and detecting the obtained spectrum.

- Types of sources:
    1. Broadband light sources : tungsten bulbs and arc lamps (emit light over wide range of frequencies)
    2. Line sources : Geissler tubes and hollow cathode lamps (give a particular frequency)
    3. Laser sources : line sources with high intensity

- Methods of dispersing spectra:
    1. Refraction :
    2. Diffraction

3. Interference

- Optical detectors:
    1. Photographic - Radiation is detected through the change in chemical properties/composition (e.g. photographic film)
    2. Photoemissive - Radiation is incident on the sensor which results in emission of electrons
    3. Photoconductive - Radiation is detected by change in conductivity of semiconductors due to incident light (e.g. photodiode)