Q 12 Explain four types of interactions between EMR and atmosphere, and what are the main reasons for various colors of sky and clouds. For example, why do we see blue sky in mid-day and reddish/yellowish sky at sunset?

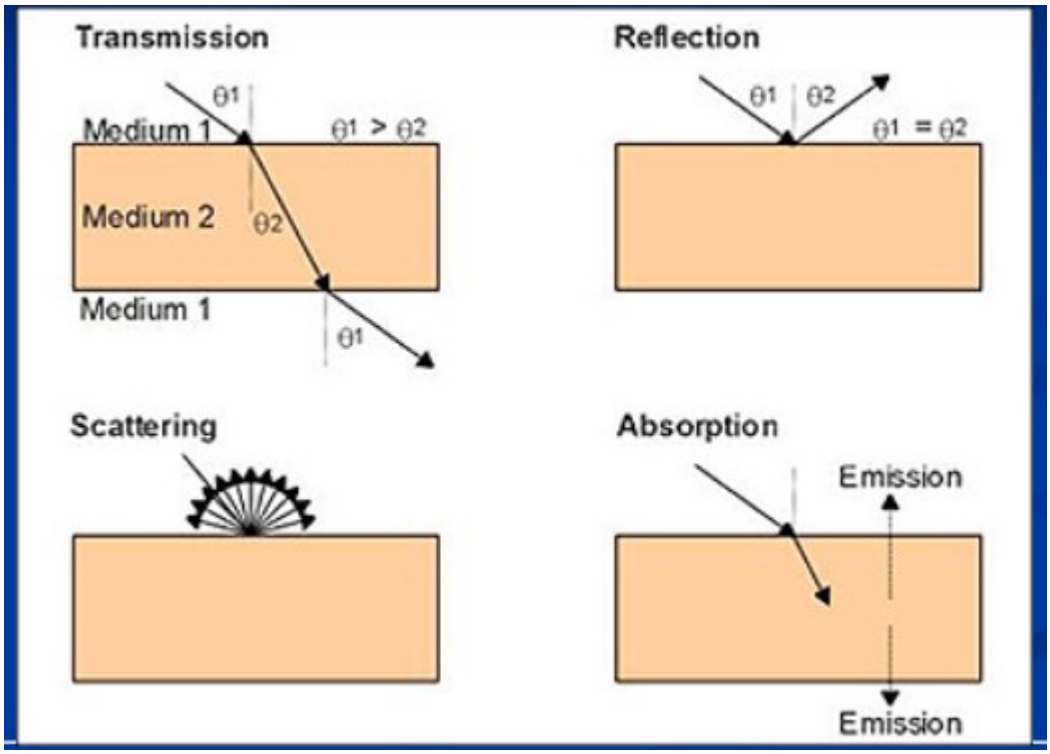
Absorption. Molecules in the atmosphere to absorb energy at various wavelength.

Diffraction

Reflection

Refraction

Scattering. Atmospheric scattering is unpredictable diffusion of radiation by particles in the atmosphere. Scattering is the process where an atom, molecule or particle redirects energy. Rayleigh scattering – atmosphere atom. Mie scattering – aerosol. Non selective scattering – cloud.



The colour of sky and clouds is mainly because of the scattering. The sky is blue is due to the wavelength of blue light is shorter than the red light, so it is more likely to be scattering while other longer wavelength light are going through the atmosphere. And at different weather situation, the practice in atmosphere are different which leading to the different wavelength light be scattering, those the reason why the sky and clouds shows various colour.

At sunset, solar radiation must traverse a longer path through the atmosphere. Viewing a setting sun, the energy reaching the observer is largely depleted of blue radiation, leaving mostly red wavelengths (Rayleigh). Dust/smoke adds additional scattering with a wavelength dependence that increases the red sky effect (Mie)

Q 13 What are the differences between active and passive remote sensing systems? Give one example for each system. Discuss the pros and cons of these systems.

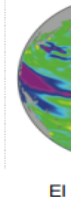
Passive instruments detect natural energy that is reflected or emitted from the observed scene. Passive instruments sense only radiation emitted by the object being viewed or reflected by the object from a source other than the instrument. Example: SPOT, Landsat

Active instruments provide their own energy (electromagnetic radiation) to illuminate the object or scene they observe. They send a pulse of energy from the sensor to the object and then receive the radiation that is reflected or backscattered from that object. Example: LiDAR, SAR

	Pros	Cons
Passive	Only need energy supply for sensor Cost-effective	Can only take place when is illuminating the earth. It does not work when no reflected energy available. Seasonal dependency
Active	Obtain measurements anytime regardless of the time of the day or season Can be used for examining wavelengths that are not sufficiently provided by the sun such as microwaves Better control of noise sources Many different source/receiver configurations can be used allowing for a wide variety of survey design.	Both sources and receivers are under human control, human error Need more funding support Need more energy to support the operation of both sources and receivers

Q 14 What are the advantages and disadvantages of airborne remote sensing platforms? What are the advantages and disadvantages of satellite remote sensing platforms?

Advantages and disadvantages of satellite remote sensing



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advantages

- global data set of uniform quality
- rapid data acquisition
- no need to obtain permission to gather data
- can revisit on a regular basis for lifetime of satellite (5-10 years)
- spacecraft provide stable platforms

disadvantages

- high cost of satellite systems
- takes 10 years + to develop, build, test, and launch
- possibility of single point failure

Aircraft have several useful advantages as platforms for remote sensing systems.

- Aircraft can fly at relatively low altitudes thus allowing for sub-meter sensor spatial resolution.
- Aircraft can easily change their schedule to avoid weather problems such as clouds, which may block a passive sensor's view of the ground.
- Last minute timing changes can be made to adjust for illumination from the sun, the location of the area to be visited and additional revisits to that location.
- Sensor maintenance, repair and configuration changes are easily made to aircraft platforms.
- Aircraft flight paths know no boundaries except political boundaries.

Disadvantages of aircraft as platforms in remote sensing.

- Getting permission to intrude into foreign airspace can be a lengthy and frustrating process.
- The low altitude flown by aircraft narrows the field of view to the sensor requiring many passes to cover a large area on the ground.
- The turnaround time it takes to get the data to the user is delayed due to the necessity of returning the aircraft to the airport before transferring the raw image data to the data provider's facility for preprocessing.

Q 15 What is the major difference between thermal infrared remote sensing (3 -100 µm) and visible and near infrared (0.4 – 2.5 µm) based remote sensing.

Table 2 - Sensitivity of each band on the Landsat Thematic Mapper instrument

Wavelength band number	Location in the EM Spectrum	Principal Use
1	Blue	Soil differentiation
2	Green	Vegetation productivity
3	Red	Chlorophyll absorption
4	Near-infrared	Biomass Surveys
5	Mid-infrared	Vegetation moisture
7	Mid-infrared	Vegetation moisture

Q 16 In radar remote sensing, corner reflection, surface scattering and volume scattering determine the brightness / intensity of a pixel in the radar image. Is it true that higher volume scattering will always produce higher intensity in radar image? Why?

No, higher volume scattering means large of incidence light was scattered random direction, thus made the microwave which back to the sensor is decreased. This will resulted in the lower intensity in radar image

Q 17 Multi-resolution data merging is useful for a variety of applications. SPOT data are well suited to this approach as the 10 metre panchromatic data can be easily merged with the 20 metre multi-spectral data acquired simultaneously. Explain the advantages of panchromatic and multi-spectral data and what pan sharpening can provide in bringing the two together.

Advantages of panchromatic

Generally of a much higher spatial resolution than the multispectral images from the same satellite

Advantages of multi-spectral data:

- The angular velocity of the mirror can be slower so it improves the stability of the platform
- A great “dwell time” for each IFOV so it improves the radiometric sensitivity of the system
- Allow extraction of additional information the human eye fails to capture with its receptors for red, green and blue.

Pan sharpening

The process of merging high-resolution panchromatic and lower resolution multispectral imagery to create a single high-resolution colour images. It can increase image quality. Pan sharpening produces a high-resolution color image from three, four or more low-resolution multispectral satellite bands plus a corresponding high-resolution panchromatic band. Pan sharpening uses spatial information in the high-resolution grayscale band and color information in the multispectral bands to create a high-resolution color image, essentially increasing the resolution of the color information in the data set to match that of the panchromatic band.

Q 18 What is a sun-synchronous orbit and why is it important for land resource mapping? What is a geostationary orbit and when is this type of orbit used?

Typical sun-synchronous orbits are about 600-800 km in altitude, with periods in the 96-100 minutes range, and inclinations of around 98°.

When the satellite ascends or descends over the same latitude of the Earth, it will be conducive to earth observation. The orbit of the satellite and the sun will maintain a fixed relative orientation, ensuring that the solar panel will always turn to the sun and contribute to the energy of the satellite Supply, but also conducive to the temperature control of the satellite instrument compartment, especially for long-life business weather satellites; the satellite can achieve global observation twice a day due to the operation of the satellite around the poles and the rotation of the Earth itself

The satellites in Geostationary orbit has the same direction the earth is spinning, it will exactly match the rotation of the earth. Weather, communication and global positioning satellites are often in this orbit

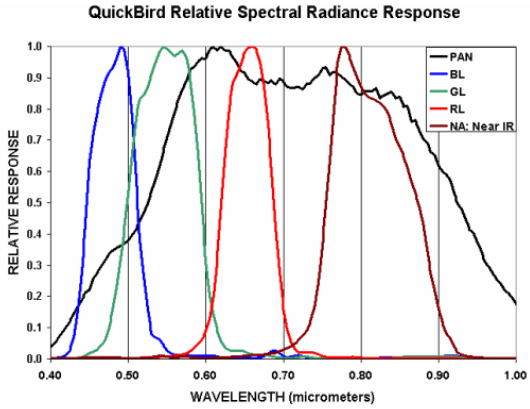
Q 19 What is the instantaneous field of view? What are the advantages of a large IFOV

The instantaneous viewing aperture or angular spatial resolution corresponding to a resolution cell is called IFOV

Larger IFOV means:

- Greater quantity of total energy on a detector
- More sensitive scene radiance measurements due to higher signal levels
- Improved radiometric resolution
- Signal greater than background noise
- Higher signal-to noise ratio
- Longer dwell time

Q 20 The following figure shows the relative spectral radiance response for the 5 bands of the imaging sensor onboard the QuickBird satellite: panchromatic (PAN), blue-light (BL), green-light (GL), red-light (RL) and near infrared (NA). Which band has the highest spectral resolution? Which band is likely to deliver the best spatial resolution? Why?



Spectral resolution: multispectral images resolve even finer differences of spectrum or wavelength than is needed to reproduce colour, thus multispectral images have higher spectral resolution than normal colour images

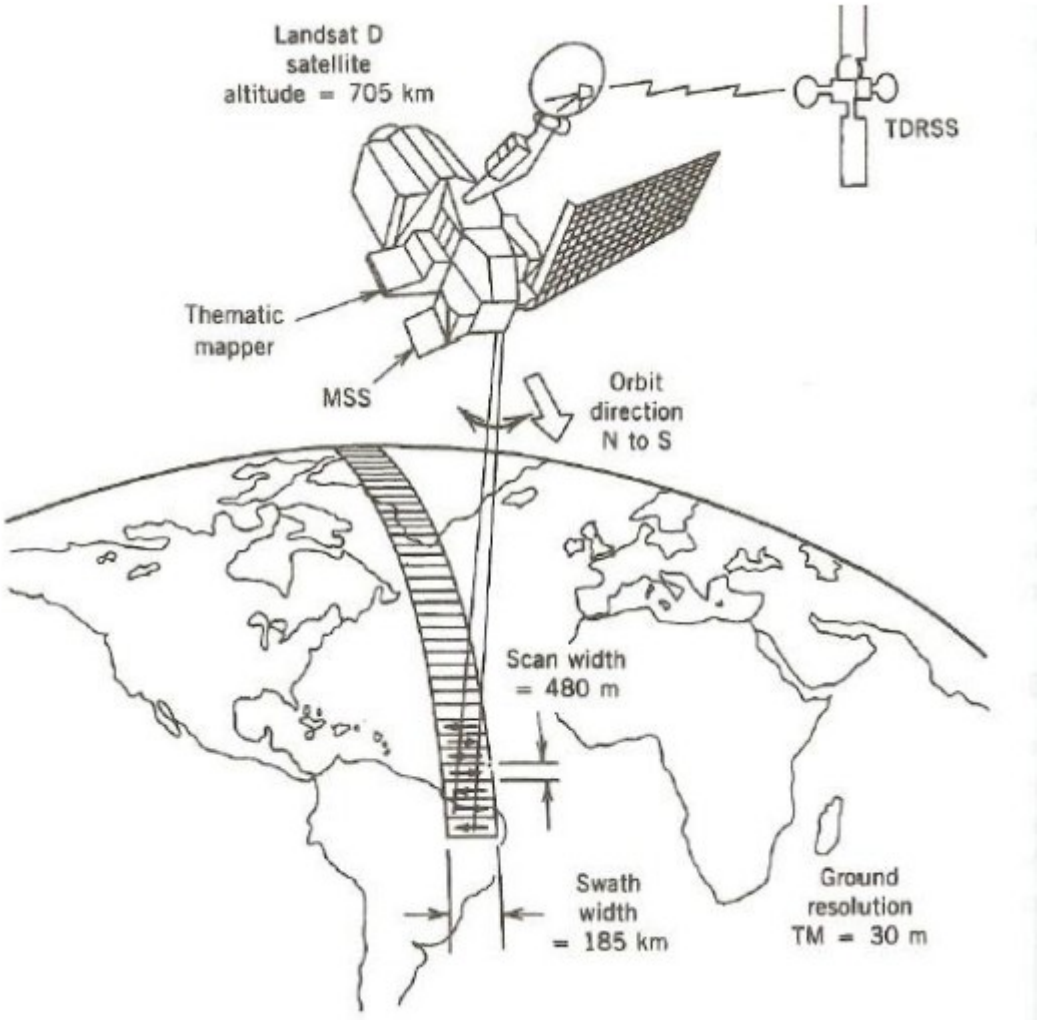
波长范围值越宽，光谱分辨率越低

Spatial resolution, PAN best

***Q 21 702 ABC Sydney (official call sign: 2BL) is an ABC radio station in Sydney, Australia. It is the flagship station in the ABC Local Radio network and broadcasts on 702 kHz on the AM dial. Calculate the wavelength of the signal from this radio station.* (5 marks)**

Q 22 The light from a distant star displays an emission spectrum that peaks at a wavelength of 0.25 micrometers. Calculate its apparent surface temperature. **(5 marks)**

Q 23 The following figure shows the Landsat-D mapping geometry. The background image is the earth surface. A Landsat track from north to south is shown on the earth surface. Scan width, swath width, spatial resolution, the altitude of the satellite are all shown in the figure. Answer the following questions:



a) Based on the figure, what is the scanning configuration of the system? **(2 marks)**

b) What is the type of orbit of the satellite? ***(2 marks)***

descending

c) How many pixels each scan line has? ***(2 marks)***

480/30=160

d) If the satellite moves at a speed of about 7 km/second, how many scans will be in each second? ***(2 marks)*** **and how much the scan frequency (Hz) will be?** ***(2 marks)***

e) We know this Landsat has 7 bands, and radiometric resolution of the image is 8 bits, what is the data stream per second? *(4 marks)*

f) If the detector has size of 0.1 mm across and the focal length of the detector is about 2.438 m, what is the IFOV in terms of degree and mrad *(4 marks)*. Based on the IFOV and altitude of the satellite, you can also calculate the pixel size (or spatial resolution) in unit of meter. Is your result similar to 30 m? (show your calculation). *(2 marks)*

g) Calculate the FOV in degree and mrad of the sensor. *(3 marks)*