ATSC 201 Fall 2024
Chapter 8: A1f, A4f, A7f, A8f

Total marks out of 11.5

Chapter 8

A1f)
(2.5 marks)

Using Fig. 8.4, identify whether the following (µm) are in a window, dirty window, shoulder, or opaque part of the transmittance spectrum, and identify which sketch in Fig. 8.2 shows how the Earth would look at that wavelength. [Hint: transmittance of ≥ 80% indicates a window.]
f) 1.37

Solution:
1.37 µm is in a dirty window.

This wavelength has relatively low transmittance so would look like Fig 8.2 f.

Discussion: A 1.37 µm wavelength is in the infrared spectrum. There is significant molecular emittance and some molecular scattering at this wavelength, leading to transmittance of ~15%. This means that the satellite sees the earth and clouds quite faintly.

A4f)
(2.5 marks)

Find the brightness temperature for the following wavelengths (µm), given a radiance of 10^(-15) W/(m^2 * µm *sr): f) 4.5

Given:	λ (µm) =	4.5	
	Bλ =	1E-15	W/(m^2 * µm * sr)
Find:	TB =	?	K

Use eqn. 8.2:

$$T_B = \frac{c_2 / \lambda}{\ln\left(1 + \frac{c_{1B} \cdot \lambda^{-5}}{B_\lambda}\right)}$$

where:	c1B =	1.19E+08	W*m-2*µm4*sr-1
	c2 =	1.44E+04	µm*K

TB =	**70.09 K**
	-203.06 °C

Check: Units ok. Physics ok.

Discussion: The radiance given in this question is very small so the resulting brightness temperature is also small. If the wavelength was smaller, we would get a larger brightness temperature because shorter wavelengths carry more energy.

A7f) (3 marks)

For the following altitudes (km) above the Earth's surface, find the satellite orbital periods: f) 10,000.

Given: satellite altitude = 10000 km
10000000 m

Find: t_orbit = ? s

Use eqn. 8.8:

$$t_{orbit} = \frac{2\pi \cdot R^{3/2}}{\sqrt{G \cdot M}}$$

where: G = 6.67E-11 N*m^2/kg^2
M = 5.97E+24 kg

r_Earth = 6378 km 6378000 m

R = radius of Earth + satellite altitude = 16378000 m

t_orbit = 20856.03 s
5.79 hr

Check: Units ok. Physics ok.

Discussion: Satellites at higher altitudes move slower because they need less energy to stay in orbit.

A8f) (3.5 marks)

What shade of grey would the following clouds appear in visible, IR, and water-vapor satellite images? f) stratus

Given: stratus cloud
Find: Shade of grey in visible, IR, and water-vapor satellite images.

VIS:	White during the day.
IR:	Dark gray becase low altitude and warm temperature
WV:	invisible because moisture not reaching the upper atmosphere

Discussion: The different shades of grey in different satellite images is indicative of the different wavelengths being picked up by that satellite channel.