ATSC 201 2025
Chapter 8: A1g, A4g, A7g, A8g
Total marks out of 11.5

Chapter 8

A1g)
(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.]
g) 1.6

Solution:
1.6 µm is at a window.

This wavelength has high transmittance so would look like Fig 8.2 a.

Discussion: A 1.6 µm wavelength is in the infrared spectrum. There is no molecular emittance and very little molecular scattering at this wavelength, leading to transmittance of ~80%. This means that the satellite sees the earth and clouds quite clearly.

A4g)
(2.5 marks)

Find the brightness temperature for the following wavelengths (μm), given a radiance of 10^(-15) W/(m^2 * μm *sr): g) 4.6

Given: λ (μm) = 4.6
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 = 68.74 K
-204.41 °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.

A7g) (3 marks)

For the following altitudes (km) above the Earth's surface, find the satellite orbital periods: g) 15,000.

Given: satellite altitude = 15000 km
15000000 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 = 21378000 m

t_orbit = 31102.19 s
8.64 hr

Check: Units ok. Physics ok.

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

A8g) (3.5 marks)

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

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

Nimbostratus is a low stratus cloud so we can consider case a) on p. 234

VIS:	White during the day.
IR:	Medium-to-dark grey becase mid-altitude and medium temperature
WV:	Invisible/dark grey because moisture is near the surface

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