

1.
 - a. 10.06 microns (2 points)
 - b. accept any answer between 250 K and 260 K (3 points)
 - c. answer has to mention the greenhouse effect (2 points)
2.
 - a. IR sensor - passive (1 point)
 - b. laser sensor - active (1 point)
3. polar orbits pass over the poles, scan a different part of Earth with each orbit since Earth is rotating under it, altitude of 700-800 km, period of 2-3 days; geostationary orbit is over the equator, orbits over a single area so higher quality observations, altitude of 36,000 km (5 points)
4. Planck's law (1 point)
5.
 - a. no (2 points)
 - b. 203 m (3 points)
 - c. wavelength of light used could be decreased to 138 nm (3 points)
 - d. the hot tubs emit no detectable light at this wavelength (1 point)
6.
 - a. External Quantum Efficiency - fraction of photons incident on sensor that energize an electron (1 point)
 - b. Internal Quantum Efficiency - fraction of photons absorbed by sensor that energize an electron (takes reflection and transmittance into account) (1 point)
7. Charge Coupled Device (CCD) (1 point)
8.
 - a. Rayleigh, Mie, Geometric (0.5 points each)

- b. particle size less than the wavelength of light, particle size equal to the wavelength of light and particle size greater than the wavelength of light, respectively (0.5 points each)
9. 550 nm (2 points)
- 10.
- a. 2.07 eV (2 points)
 - b. 500 THz (2 points)
11. The atmosphere (specifically the ozone layer) absorbs UV photons (1 point)
12. atmospheric windows (1 point)
- 13.
- a. El Nino (1 point)
 - b. La Nina (1 point)
 - c. irregularly every 2-7 years (1 point)
 - d. weakening of trade winds (1 point)
- 14.
- a. sea surface temperature (1 point)
 - b. eddy (also accept cold-core eddy) (1 point)
15. spatial resolution OR diffraction (1 point)
- 16.
- a. geosynchronous (1 point)
 - b. Band 16 (also accept CO₂ longwave infrared), 13.3 micron (1 point)
 - c. Band 15 (also accept dirty longwave infrared), 12.3 micron (1 point)
- 17.
- a. ATMS (Advanced Technology Microwave Sounder) (1 point)
 - b. Suomi NPP (National Polar-orbiting Partnership) (1 point)
 - c. CrIS (Cross-track Infrared Sounder) (1 point)
 - d. CERES (Clouds and the Earth's Radiant Energy System) (1 point)
- 18.
- a. MODIS (Moderate Resolution Imaging Spectroradiometer) (1 point)
 - b. aerosol concentration (1 point)
 - c. Saharan dust (1 point)

19.

- a. OCO-2 (Orbiting Carbon Observatory 2) (1 point)
- b. destroyed in launch failure (1 point)
- c. OCO-3, mounted on ISS (Japanese Experiment Module) (1 point)

20.

- a. Jason-3 (1 point)
- b. sea surface height anomaly, radar altimetry (1 point)
- c. Topex-Poseidon (1 point)
- d. Jason-CS, Sentinel-6 (1 point)

21. doppler shift (1 point)

22. decibels (dBZ) (1 point)

23.

- a. Earth's energy budget (1 point)
- b. W/m^2 (Watts per square meter) (1 point)
- c. longwave radiation (1 point)
- d. $340 \pm 5 W/m^2$ (1 point)
- e. value of B is averaged over the entire surface area of the Earth ($4\pi r^2$) while the solar constant only takes into account the cross-sectional area of Earth (πr^2) (1 point)
- f. Earth (1 point)

24. radiative forcing (1 point)

25. water vapor (1 point)

Total Points: 72 points

TIEBREAKER QUESTIONS: 23e, 14b, 7