National Aeronautics and Space Administration

INSTRUCTOR'S GUIDE

NASA Space Communications and Navigation

Irradiance

GRADES 10–12

Answer Key

1. What is the **area** of this aperture in square inches (in^2)?

a. 6 inches diameter → 3 inches radius

b. $Area_{circle} = \pi r^2$

$= \pi \times (3\ in)^2$

$= \pi \times 9\ in^2$

$= \mathbf{28.3\ in^2}$

Now we have the area of the LCRD aperture in imperial units.

2. Convert the LCRD telescope aperture area above into square centimeters (cm^2) and then to square meters (m^2).

$$A = \frac{28.3\ in^2}{1} \cdot \frac{2.54\ cm}{1\ in} \cdot \frac{2.54\ cm}{1\ in} = 183\ cm^2$$

$$A = \frac{183\ cm^2}{1} \cdot \frac{1\ m}{100\ cm} \cdot \frac{1\ m}{100\ cm} = \mathbf{0.0183\ m^2}$$

The LCRD aperture in metric units is **0.183 m^2**.

3. What is the irradiance of the LCRD ground station at the aperture in W/m^2 ?

Irradiance units are W/m^2

Power in milliWatts is given: 3,510 mW

Convert milliWatts to Watts:

$$3{,}510\ mW \times \frac{1\ W}{1{,}000\ mW} = 3.51\ W$$

Area in m^2 is calculated above: 0.0183 m^2

Express and simplify: $\frac{3.51\ W}{0.0183\ m^2} = \mathbf{192\ W/m^2}$

The infrared irradiance is 192 W/m^2 at the LCRD ground station's aperture. ("LCRD infrared irradiance")

4. What is the *total* solar irradiance at Earth's surface?

Apply solar atmospheric attenuation to the total solar irradiance at the top of the atmosphere:

$= 1{,}368\ W/m^2 \cdot 56\%$

$= 1{,}368\ W/m^2 \cdot \frac{56}{100}$

$= 1{,}368\ W/m^2 \cdot 0.56$

$= \mathbf{766\ W/m^2}$ of *total* solar irradiance at Earth's surface

What is the *infrared* solar irradiance at Earth's surface?

Calculate *infrared* component of total solar irradiance at surface:

$= 766\ W/m^2 \cdot 50\%$

$= 766\ W/m^2 \cdot \frac{50}{100}$

$= 766\ W/m^2 \cdot 0.50$

$= \mathbf{383\ W/m^2}$ of *infrared* solar irradiance at Earth's surface

5. How does the infrared solar irradiance at Earth's surface compare to the infrared LCRD irradiance at the telescope aperture? Which one is larger? By how much?

LCRD's 192 W/m^2 is **almost exactly half as intense** as the Sun's 383 W/m^2 on a cloudless, equatorial noon.

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