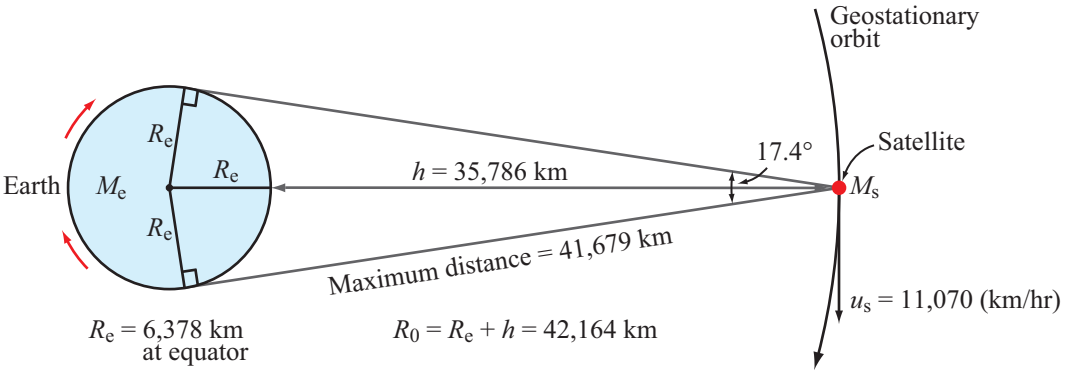
Test 10.1 Geostationary Orbit

Solution: (d)

A satellite is in geostationary orbit if its orbital period is identical with Earth's rotational period (1 sidereal day = 23.935 hours). Also, its orbit has to be such that $R_0 = 42{,}164$ km in order to balance the gravitational force F_g against the centrifugal force F_c. Consequently, its speed has to be

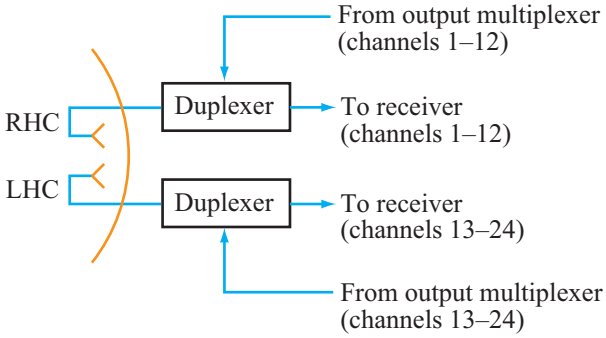
$$u_s = \frac{2\pi R_0}{T} = \frac{2\pi \times 42{,}164 \text{ km}}{23.935 \text{ hours}} = 11{,}070 \text{ km/hr}.$$



Test 10.2 Satellite Transponder

Solution: (a)

By using an antenna with two feeds, one designed for RHC polarization and the other for LHC polarization, the system ends up increasing the number of channels by a factor of 2 over the same bandwidth, thereby doubling the data rate.



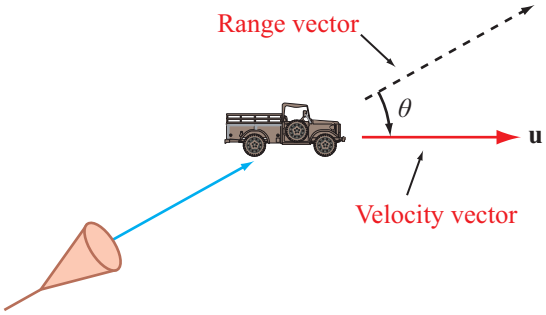
Test 10.3 Doppler Radar

Solution: (b)

At $f = 15$ GHz, $\lambda_t = c/f = 2$ cm. From Eq. (10.34),

$$f_d = -2\,\frac{u_r}{\lambda_t} = \frac{-2 \times 72 \times 10^3}{2 \times 10^{-2} \times 3600} = -2000 \text{ Hz} = -2 \text{ kHz}.$$

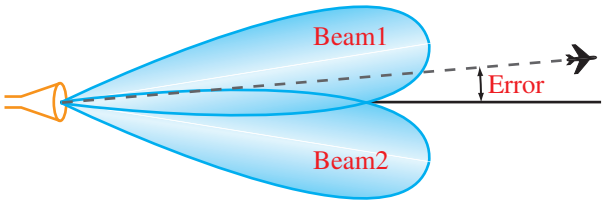
The minus sign denotes that the car is moving away from the radar.



Test 10.4 Monopulse Radar

Solution: (c)

A monopulse uses a four-beam antenna to track the direction of a target with an angular accuracy equal to a fraction of the antenna beamwidth.



Test 10.5 Satellite Orbital Period

Solution: (b)

The orbit's radius is $R_0 = R_e + h = 6,378 + 900 = 7278$ km. Rewriting Eq. (10.6) for T:

$$T = \left(\frac{4\pi^2 R_0^3}{GMe}\right)^{1/2} = \left[\frac{4\pi^2 \times (7.278 \times 10^6)^3}{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}\right]^{1/2}$$
$$= 6177.10 \text{ s} = 102.95 \text{ minutes.}$$

Test 10.6 Pulse Repetition Frequency

Solution: (c)

From Eq. (10.14),

$$f_p = \frac{c}{2R_u} = \frac{3 \times 10^8}{2 \times 100} = 1.5 \times 10^6 \text{ Hz.}$$

Test 10.7 Range Resolution

Solution: (a)

From Eq. (10.16),

$$\Delta R = \frac{c\tau}{2} = \frac{3 \times 10^8 \times 10^{-7}}{2} = 15 \text{ m.}$$

Test 10.8 Detection vs. False Alarm

Solution: (d)

To improve (increase the detection probability) the threshold detection level would need to be lowered, such as from level 2 down to level 1, thereby not missing Target 1. Doing so, however, increases the false-alarm probability because some noise spikes will be detected as targets.