Chapter 1 (Introduction) - Exercise Solutions

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1. (a)

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8 ms^{-1}}{800 \times 10^6 s^{-1}} = 0.375 \text{ m}$$

   (b)

$$\lambda = \frac{3 \times 10^8 ms^{-1}}{1.9 \times 10^9 s^{-1}} = 0.158 \text{ m}$$

   (c)

$$\lambda = \frac{3 \times 10^8 ms^{-1}}{38 \times 10^9 s^{-1}} = 0.008 \text{ m}$$

   (d)

$$f = \frac{c}{\lambda} = \frac{3 \times 10^8 ms^{-1}}{10m} = 3 \times 10^7 s^{-1} = 30 \text{ MHz}$$

2.

$$S = \frac{P}{4\pi d^2} = \frac{1 \times 10^3 \text{ W}}{4\pi(2 \times 10 \times 10^3 m)^2} = 1.989 \times 10^{-7} \text{ W m}^{-2} = 0.199\,\mu\text{W m}^{-2}$$

3. (a) From $h = 1$ m, in km:

$$d = \sqrt{(2r + h)h} = \sqrt{(2 \times 6.371 \times 10^6 + 1)1} = 3.57\text{km}$$

   or (via book)

$$d \approx \sqrt{2h} = \sqrt{2(3.28 \text{ ft})} = 2.56 \text{ miles} \approx 4.12 \text{ km}$$

   From $h = 10$ m, in km:

$$d = \sqrt{(2r + h)h} = \sqrt{(2 \times 6.371 \times 10^6 + 10)10} = 11.288\text{km}$$

   or

$$d \approx \sqrt{2h} = \sqrt{2(32.8 \text{ ft})} = 8.099 \text{ miles} \approx 13.034 \text{ km}$$

Note that the ratio of distances to the horizon can be calculated quickly when comparing heights above ground using

$$\sqrt{\frac{h_2}{h_1}}$$

where h_2 and h_1 are the higher and lower heights respectively, since

$$\frac{d_2}{d_1} = \sqrt{\frac{2rh_2 + h_2^2}{2rh_1 + h_1^2}} \approx \sqrt{\frac{h_2}{h_1}}$$

for $2rh >> h^2$. Thus at a height of 10 m, one can see $\sqrt{\frac{10}{1}} = 3.16$ times further than at 1 m.

(b) Radio horizon from $h = 1$ m, in km:

$$d = \sqrt{(2\frac{4}{3}r + h)h} = \sqrt{(\frac{8}{3} \times 6.371 \times 10^6 + 1)1} = 4.121\text{km}$$

and from $h = 10$ m:

$$d = \sqrt{(2\frac{4}{3}r + h)h} = \sqrt{(\frac{8}{3} \times 6.371 \times 10^6 + 10)10} = 13.034\text{km}$$

(c) Using the horizons calculated above, we simply add: $4.121 \text{ km} + 13.034 \text{ km} = 17.155 \text{ km}$.