Solutions to Homework Problems Set 1

Problem 1.

$$F_g = G\frac{m_1 m_2}{r^2}\hat{r} \Rightarrow F_g = (6.67\times10^{-11})\left[\frac{N\cdot m^2}{kg^2}\right]\frac{(9.1\times10^{-31})(1.67\times10^{-27})\left[kg^2\right]}{(0.052\times10^{-9})^2\left[m^2\right]} = 3.7\times10^{-47}\,N$$

The ratio $\frac{F_e}{F_g} = 2.3\times10^{39}$

Problem 2.

Lets assume that the total number of electrons in this case is ***N*.** Then the total charge is given by $Q = Ne$, where is the the charge of an electron. We can express the current as

$$I = \frac{\Delta Q}{\Delta t} \text{ or } Q = It = Ne$$

so

$$N = \frac{It}{e} = \frac{1.0A\times1.0\sec}{1.6\times10^{-19}C} = 6.25\times10^{18} \text{ electrons}$$

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Problem 3.

WBEZ	91.5 MHz	$\lambda \approx 3.3$ m
WKSC-FM	103.5 MHz	$\lambda \approx 2.9$ m
WGN	720 KHz	$\lambda \approx 416$ m
WMAQ	670 KHz	$\lambda \approx 447$ m
Microwave oven	2.45 GHz	$\lambda \approx 12.2$ cm

Problem 4. $f = 900\, MHz$

$$\lambda_{air} = \frac{c}{f} = \frac{2.99702458 \times 10^{8}\, m/\sec}{900 \times 10^{6} \sec^{-1}} = 33.3\, cm$$

$$\lambda_{cable} = \frac{vf \times c}{f} = \frac{0.66 \times 2.99702458 \times 10^{8}\, m/\sec}{900 \times 10^{6} \sec^{-1}} = 22\, cm$$

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Problem 5.

a. Visible light
b. Radio wave
c. Infrared radiation
d. microwave

Problem 6.

In this case we can safely assume that the inverse square law applies. The distance increases by a factor of

$$\frac{390{,}000}{36{,}000} = 10.8$$

The received intensity will therefore be smaller by the factor $1/(10.8)^2 = 0.0085$. Hence the intensity at 390,000 km will be $2\mu W/m^2 \times 0.0085 = 0.017\ \mu W/m^2$ or 17 nW/m^2.