Useful and not so useful formulas and constants (not all are necessary for solving the problems):

An uncoded QPSK signal carries 2 bit pr. symbol.

The bandwidth $B=1/T_s$, where T_s is the symbol period

$L_o=(4\pi d/\lambda)^2$

AWGN spectral power is $N=kTB$, where T is the temperature

$EIRP= P_tG_t$

$S/N = ((S/N_{up})^{-1} + (S/N_{down})^{-1})^{-1}$

The 3dB beam width for the main lobe of an antenna is: $\theta_{3dB}= k\cdot\lambda/A$

Boltzmann's constant $k = 1.38 \times 10^{-23}$ J/K

The speed of light $c = 3\cdot 10^8$m/s

X in deciBel (dB): $X_{dB} = 10\log_{10}(X_{lin})$

$\Delta V = V_{eff} \cdot \ln (M_{initial}/M_{final})$

$I_{sp} = V_{eff} / g_0$ (V_{eff} is the effective exhaust speed and $g_0 = 9.81$ m/s^2)

$I_{sp} = (F_{thrust} \cdot \Delta t/\Delta M_{propellant})$

The velocity in an orbit is given by

$$v = \sqrt{\frac{\mu}{r}}$$

where $\mu = 398603.2$ km^3/s^2

The Earth radius is R=6378 km

The velocity in an elliptic orbit is

$$v_2 = \sqrt{\mu \cdot (\frac{2}{r} - \frac{1}{a})}$$

where a is the semi major axis, given by $a = ½ (R_a+R_p)$ where R_a is the radius of apogee and R_p is the radius of the perigee.

The eccentricity of an ellipse is $e = (R_a-R_p) / (R_a+R_p)$

The specific mechanical energy in an orbit is $\varepsilon = -\mu/2a$