Spacecraft and missions: Solutions for Problem sheet 2

1. $r_p = a(1-e) \Rightarrow a = \frac{r_p}{1-e} = \frac{r_\oplus^{EQ} + h_p}{1-e} = 7295.83$ km

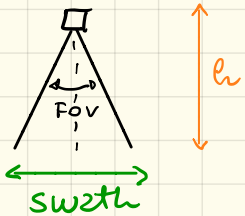
$r_a = a(1+e) = 7587.67$ km

$h_a = r_a - r_\oplus^{eq} = 1203.67$ km

$r_{\oplus\,equator} = 6384$ km

$r_{\oplus\,pole} = 6353$ km

2.



$swath_p = 2h_p \tan\frac{FOV}{2} = 286.28$ km

$swath_a = 2h_a \tan\frac{FOV}{2} = 555.78$ km

resolution at $p = \frac{286.28\text{ km}}{1000} = 286.28$ m/px

resolution at $a = \frac{555.78\text{ km}}{1000} = 555.78$ m/px

3. $r = \frac{a(1-e^2)}{1+e\cos\theta}$ $\quad r(\theta = 90°) = a(1-e^2) = 7284.16$ km $\quad h_{poles} = p - r_\oplus^{pole}$

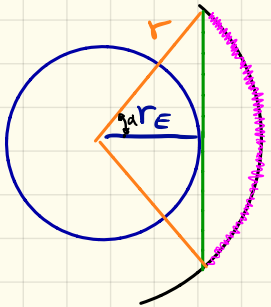
$h_{poles} = 931.16$ km ; $swath_{poles} = 2h_{poles}\tan\frac{FOV}{2} = 429.95$ km

resolution at poles $= \frac{425.41\text{ km}}{1000} = 429.95$ m/px

4. $\frac{1}{2} v_p^2 - \frac{\mu}{r_p} = -\frac{\mu}{2a} \Rightarrow v_p^2 = \frac{2\mu}{r_p} - \frac{\mu}{a} \Rightarrow v_p = \left(\frac{2\mu}{r_p} - \frac{\mu}{a}\right)^{\frac{1}{2}} = 7.69 \text{ km/s}$

$\mu_E = 3.986 \times 10^5 \frac{km^3}{s^2}$

At perige $\dot{r}_p = 0 \quad v_p = r_p \dot{\theta} \Rightarrow \dot{\theta} = \frac{v_p}{r_p} = 1.09 \times 10^{-3} \frac{rad}{s}$



$r_E = r \cos\alpha$

$\alpha = \cos^{-1} \frac{r_E^{EQ}}{r} = 0.42 \text{ rad}$

$t = \frac{2\alpha}{\dot{\theta}} = 771.84 \text{ s}$