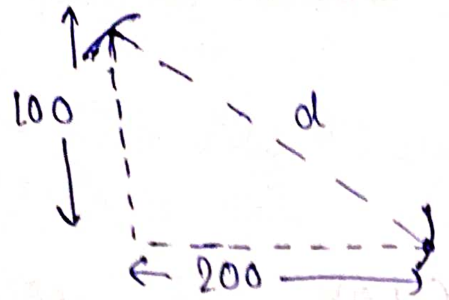
Q1-part b



$d = \sqrt{(100)^2 + (200)^2}$ km

$= 223.608$ km

(1)

Power transmitted = 2W

Transmission frequency = 5.8 GHz = f

$\therefore \lambda = c/f = \dfrac{3 \times 10^8}{5.8 \times 10^9} = 0.05172$ m

now according to Friis's eqn we have

$$P_o = \frac{P_t G_r G_d \lambda^2}{(4\pi)^2 (d)^2}$$

(P_o = Power output, P_t = power transmitted)

$$\frac{P_o (0.223608)^2 (4\pi)^2}{(2)(0.05172)^2} = G_r G_d$$

P_o for a reliable communication link depends upon a lot of factor like environmental factor, type of modulation used.

For antenna based communication system the most common technique used is QAM (Quadrature Amplitude modulation). The following calculations are done on this basis.

There are several schemes in QAM

→ 2-QAM SNR = 8-10 db

→ 16-QAM SNR = 12-16 db

→ 64-QAM SNR = 18-22 db

→ 256-QAM SNR = 24-28 db

let us take SNR for each order type of modulation and take the average of the upper and lower levels

P_o = output power

N = noise power

2-QAM

SNR = 9 dB

$$9dB = 10\log_{10}\left(\frac{P_o}{N}\right) \Rightarrow 0.9 = \log_{10}(P_o/N)$$

now N can be estimated as $\boxed{N = K \times T \times B}$ → bandwidth of the receiver in Hz

& Noise density

boltzman's constant

temperature in K

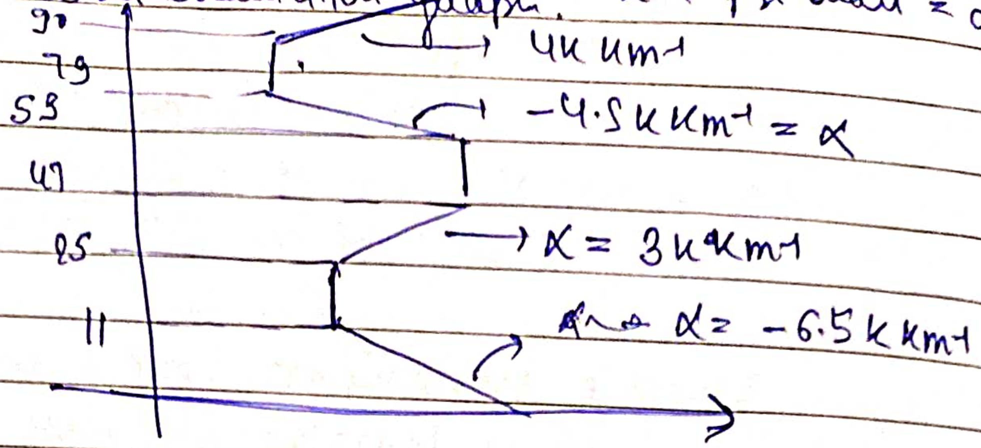
- $K = 1.38 \times 10^{-23}$

~~let the temp~~

Now the temperature will tend to vary from 0 to 100 km altitude

$$\int dN = \int KB\, dT$$

Temperature variation graph. α = lapse rate = dT/dH



with this model of atmosphere we'll have.

$$\int dN = \int KB(\alpha dH)$$

$$N - N_g = KB\left[(-6.5)(11) + 3(47-25) - 4.5(79-53) + 4(10)\right]$$

$$N - N_g = KB[-71.5 + 66 - 117 + 40]$$

$$N - N_g = KB(-82.5)$$

$$N = N_g - (1.38 \times 10^{-23} \times 5.8 \times 10^{9} \times 82.5)$$

$$N = N_g - 660.33 \times 10^{-14}$$

assume $N_o = 0$

$$N = -660.33 \times 10^{-14}$$

$$\therefore N_o = -660.33 \times 10^{-14} \times 5.8 \times 10^{9} = -3.832 \times 10^{-2} \ \omega$$

$$SNR = 10\log(|P_o/N_o|)$$

assuming average SNR to be of 20 dB

$$2 = \log|(P_o/N_o)| = 100 = P_o/N_o$$

$$\Rightarrow 100 \times |N_o| = 3.832\,\omega = P_o$$

$$\therefore G_r \times G_p = 3.832 \times 1.048 \times 10^{10} = 4.015 \times 10^{10}$$

assuming $G_r = G_p$

$$\rightarrow G_r = G_p = 2.0037 \times 10^{5}$$

$G_r = G_D \text{ (in dB)} = 10 \log_{10}(2 \times 10^5)$

$= 10[5 + 0.3]$

$= 53 \text{ dBi}$

G_r and G_D may not be necessarily equal though.

MARKET ANALYSIS

Following antenna can be used for receiver and transmitter respectively for efficient communication

Rx	Tx
• Intellian V240M Antenna.	1) Rocket - Dish RD-5G34
• Kathrein Mobile communication	2) Microtik manT30 PA antenna.
• AdvanceTech wireless	3) Cambium networks 450i dish antennas
• Global invacom group VSAT antenna series.	4) KP performance antennas
• General dynamic SATCOM Series antennas.	5) Laird connectivity Parabolic Antennas
• Cobham SATCOM Series.	6) RadioWaves parabolic antennas
	7) Laird connectivity antenna.

- The price range of transmitting antenna is from ₹10,000 to ₹45,000, depending upon band and other equipment required for deployment.
- The average gain of the transmitting antenna is from 34dBi to 42dBi

When it comes to ground station antenna given the high gain values the require for achieving reliable linkage they prices will be higher than that of transmitting antenna

The price range can be from ₹80,000 to ₹2,50,000 or higher, but the price will vary according to our needs.

The gain range of these antenna will be 50-70 dBi.