



## SOLUTION

### TQ5 [10 points]

5.1 Pressure inside the flux tube = Pressure outside the flux tube (surroundings)

( Magnetic pressure + Gas pressure inside ) = Gas pressure outside

Particularly,

$$\frac{B_0^2}{2\mu_0} + P_{gas_{in}} = P_{gas_{out}} \quad [2 \text{ points}]$$

$$\frac{B_0^2}{2\mu_0} = P_{0_{out}} - P_{0_{in}} \quad \text{Eq. (1)}$$

Similarly, for a particular height  $z$ ,

$$\frac{B(z)^2}{2\mu_0} = e^{-z/H} (P_{0_{out}} - P_{0_{in}}) \quad \text{Eq. (2)}$$

[2 points]

Dividing equation (2) to (1),

$$\frac{B(z)^2}{B_0^2} = e^{-z/H}$$

To finally get

$$B(z) = B_0 e^{-z/2H} \quad [3 \text{ points}]$$

5.2 At  $z = H$ ,  $B = B_0 e^{-z/150}$

$$0.03 = 0.3 e^{-\frac{z}{2 \times 150}}$$

$$z = 300 \times \ln 10$$

$$z = 300 \times 2.301$$

$$z = 690 \text{ km}$$

[3 points]