Q- What are the three longest wavelengths for standing sound waves in a 121 cm long tube that is
(a) Open at both ends (b) Open at one end and closed at the other.

(a) In an open tube (organ pipe) for the normal mode of the standing waves the antinodes are at the two open ends and one node at the center. So the length of the tube is equal to the

$$2*(\lambda/4) = 121 \text{ cm}$$

Gives $\lambda_1 = 121*2 = 242 \text{ cm} = 2.42 \text{ m}$

In the second mode (second harmonic or first overtone) there are two nodes are in between three antinodes and hence the length of the tube is equal to

$$4*(\lambda/4) = 121 \text{ cm}$$

Gives $\lambda_2 = 121 \text{ cm} = 1.21 \text{ m}$

And in the third mode there are three nodes in between four antinodes and hence the length of the tube is given by

$$6*(\lambda/4) = 121 \text{ cm}$$

Gives $\lambda_3 = 121*2/3 = 80.667 \text{ cm} = 0.8067 \text{ m}$.

(b) In a close organ pipe one node will be at the close end and one antinode will be there at open end. So the length of the tube in the normal mode will be equal to the distance between the consecutive node and antinode and is equal to

$$(\lambda/4) = 121 \text{ cm}$$

So $\lambda_1 = 4*121 = 484 \text{ cm} = 4.84 \text{ m}$.

In the second mode of vibration one more node and antinode will be in between and hence

$$3*(\lambda/4) = 121 \text{ cm}$$

so $\lambda_2 = 4*121/3 = 161.33 \text{ cm} = 1.6133 \text{ m}$.

And there will be two pairs of nodes and antinodes in-between in the third mode of vibration and hence

$$5*(\lambda/4) = 121 \text{ cm}$$

Gives $\lambda_3 = 4*121/5 = 96.8 \text{ cm} = 0.968 \text{ m}$.