Torque problem: Penguin mobile

A toy "mobile" of penguins hangs motionless. Each cross-bar is horizontal, of negligible mass & extended 3 times as far to the right of the supporting wire as to the left. Mass of penguin 1 is 9.6g.

What are the masses of penguins 2 & 3?

Solution: First look at just the wire holding penguins 2 and 3:

Because the penguins are in equilibrium, the net torque on the system is 0. Calculate the torque due to the weight of each penguin about point P, the suspension point: take anti-clockwise torques to be positive

penguin 2: force $W_2$ is acting at perpendicular distance $x$ from P so
$$\tau_2 = + x W_2 = + m_2 g x$$
penguin 3: force $W_3$ is acting at perpendicular distance $3x$ from P so
$$\tau_3 = - 3x W_3 = - 3m_3 g x$$
equilibrium \Rightarrow \tau_2 = \tau_3$$
so $$m_2 g x - 3m_3 g x = 0$$
$$m_2 g x = 3m_3 g x$$
$$m_2 = 3m_3$$

Now do the same for the wire holding penguin 1 and penguins 2 and 3 together:

penguin 1: force $W_1$ is acting at perpendicular distance $y$ from P so
$$\tau_1 = + y W_1 = + m_1 g y$$
penguins 2+3: force $W_{2+3}$, (combined weight), is acting at perpendicular distance $3y$ from P so
$$\tau_{2+3} = - 3y W_{2+3} = - 3(m_2 + m_3) g y$$
equilibrium \Rightarrow m_1 g y - 3(m_2 + m_3) g y = 0$$
so $$m_1 = 3(m_2 + m_3) = 3 (3m_3 + m_3) = 12m_3$$
so $$m_3 = m_1/12 = 0.8 \text{ g}, \quad m_2 = 3m_3 = 2.4 \text{ g}$$