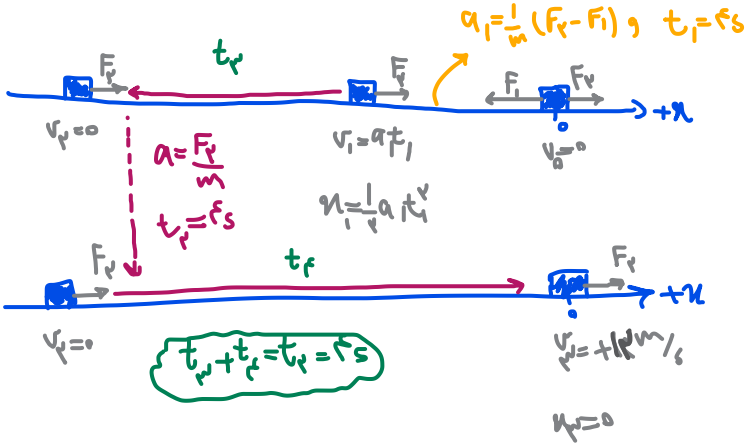

$x_1 \to x_2$:
$$x_2 = x_1 + v_1(t_2-t_1) + \frac{1}{2}a(t_2-t_1)^2$$
$$0 = \frac{F_2-F_1}{2m}(4^2) + \frac{4}{m}(F_2-F_1)(4) + \frac{F_2}{2m}(4^2)$$
$$0 = 4F_2 - 4F_1 + 8F_2 - 8F_1 + 4F_2 \to 16F_2 - 12F_1 = 0 \quad (I)$$

$1 \to 2$:
$$v_2 = v_1 + \frac{F_2}{m}t_2$$
$$0 = a_1t_1 + \frac{F_2}{m}t_2$$
$$0 = \frac{F_2-F_1}{m}t_1 + \frac{F_2}{m}t_2$$
$$0 = (F_2-F_1)t_1 + F_2t_2 \to t_2 = 4\left(\frac{F_1-F_2}{F_2}\right)$$

$2 \to 3$:
$$v_3 = v_2 + \frac{F_2}{m}t_3$$
$$12 = \frac{F_2}{m}t_3$$
$$\to t_3 = \frac{24}{F_2}$$

$$\to t_2+t_3 = 4 \to 4\left(\frac{F_1-F_2}{F_2}\right) + \frac{24}{F_2} = 4$$
$$4(F_1-F_2) + 24 = 4F_2 \to 4F_1 - 8F_2 = -24$$
$$\to \boxed{F_1 - 2F_2 = -6} \quad (II)$$

I و II :
$$16F_2 - 12F_1 = 0$$
$$-2F_2 + F_1 = -6$$

$$\to \begin{cases} 16F_2 - 12F_1 = 0 \\ -16F_2 + 12F_1 = -72 \end{cases}$$

$$-F_1 = -12 \to F_1 = 12g \quad F_2 = 9 \Rightarrow \vec{F}_2 = +9N$$
$$\vec{F}_1 = -12N$$
$$\to |\vec{F}_1 + \vec{F}_2| = 3$$