Answer on Question #79528, Physics / Other

In a car race, car A takes time t less than car B to cross the finishing line, but has a velocity v more than that of while crossing the finishing line. if a1 and a2 are acceleration of car A & B then find the relation between v, t, a1 and a2. Assume that the cars started from rest.

Solution:

For car A:

acceleration = a_1

total time $t_A = t_B - t$

final velocity $v_A = v_B + v$

For car B:

acceleration = a_2

total time = t_B

final velocity = v_B

The kinematic equation for distance:

$$s = \frac{1}{2}a_1(t_B - t)^2 = \frac{1}{2}a_2(t_B)^2$$

therefore

$$\frac{t_B - t}{t_B} = \sqrt{\frac{a_2}{a_1}}$$

$$1 - \frac{t}{t_B} = \sqrt{\frac{a_2}{a_1}}$$

$$t_B = \frac{t}{1 - \sqrt{\frac{a_2}{a_1}}}$$

Another kinematic equation:

$$s = \frac{v_A^2}{2a_1} = \frac{(v_B + v)^2}{2a_1}$$

$$s = \frac{v_B^2}{2a_2}$$

therefore

$$\frac{v_B + v}{v_B} = \sqrt{\frac{a_1}{a_2}}$$

$$1 + \frac{v}{v_B} = \sqrt{\frac{a_1}{a_2}}$$

$$v = v_B\left(\sqrt{\frac{a_1}{a_2}} - 1\right)$$

The kinematic equation for velocity:

$$v_B = a_2 t_B$$

So,

$$v = a_2 t_B\left(\sqrt{\frac{a_1}{a_2}} - 1\right) = a_2\frac{t}{1 - \sqrt{\frac{a_2}{a_1}}}\left(\sqrt{\frac{a_1}{a_2}} - 1\right) = a_2 t\frac{\left(\frac{\sqrt{a_1} - \sqrt{a_2}}{\sqrt{a_2}}\right)}{\left(\frac{\sqrt{a_1} - \sqrt{a_2}}{\sqrt{a_1}}\right)}$$

$$v = t\frac{a_2\sqrt{a_1}}{\sqrt{a_2}} = t\sqrt{a_1 a_2}$$

Answer: $v = t\sqrt{a_1 a_2}$.