21-R-WE-ZA-47 Solution

Question: The motor M applies a force F to the cord attached to the block of mass $m\ kg$ shown. The force follows the graph shown as a function of time. Find the velocity of the block at time $t_A\ s$ and $t_B\ s$. We know that $F_1\ N$, $F_2\ N$, $t_1\ s$, and the block starts with a velocity of $v_0\ m/s$.

Solution:

We start by writing an expression for the force as a function of time. Then we use the principle of impulse and momentum to find the velocity at t_A seconds.

$$F_{0-1} = F_1 + (F_2 - F_1)/t_1 t$$

$$mv_0 + 4\int_0^{t_A} F_{0-1}dt - \int_0^{t_A} mgdt = mv_1$$

$$v_1 = [(mv_0) + 4(F_1 t_A + ((F_2 - F_1)/t_1)/2 * t_A^{\,2}) - mgt_A]/m$$

We use this velocity in the principle of impulse and momentum equation for the second part of the graph where force is constant.

$$F_{1-2} = F_2$$

$$mv_1 + 4\int_{t_A}^{t_B} F_{1-2}dt - \int_{t_A}^{t_B} mgdt = mv_2$$

$$v_2 = (mv_1 + 4F_{1-2}(t_B - t_A) - mg(t_B - t_A))/m$$