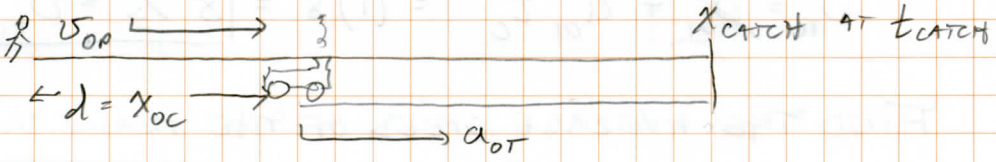
T3 2.61

A PASSENGER RUNNING AT $v_{op} = 8\ m/s$ IS A DISTANCE d FROM A TRAIN WHEN IT STARTS AT $a_{OT} = 1\ m/s^2$.

a) IF $d = 30m$, WILL SHE CATCH THE TRAIN?



WRITE OUT THE DISTANCES

$$x_p = x_{OP}^{\,0} + v_{OP} t_{CATCH} + \tfrac{1}{2} a_{OP}^{\,0} t_c^2 = v_{OP} t_c = x_p$$

$$x_T = x_{OT} + v_{OT}^{\,0} t_c + \tfrac{1}{2} a_{OT} t_c^2 = x_{OT} + \tfrac{1}{2} a_{OT} t_c^2 = x_T$$

EQUATE & FIND t_c

$$0 = \tfrac{1}{2} a_{OT} t_c^2 - v_{OP} t_c + x_{OT} = 0.5 t_c^2 - 8 t_c + 30$$

$$t_c = \frac{8 \pm \sqrt{64 - (4)(0.5)(30)}}{1} = 8 \pm 2 = 6 \text{ SEC OR } 10 \text{ SEC}$$

YES! PASSENGER HAS TWO CHANCES!

$t_c = 6$ SEC OR 10 SEC
→ TRAIN PASSING PASSENGER
→ PASSENGER PASSING TRAIN

b) SEE ATTACHED FOR PLOTS

FOR $t = t_{CRIT}$, THE QUADRATIC HAS ONE ROOT

$\Rightarrow$ RADICAL EQUALS ZERO: $\sqrt{b^2 - 4ac} = 0$

$\Rightarrow b^2 = 4ac$ AT $x_{OP} = d_{CRIT}$

$$v_{OP}^{\,2} = 4\left(\tfrac{1}{2} a_{OT}\right)(d_c)$$

$$d_c = \frac{v_{OP}^{\,2}}{2 a_{OT}} = \frac{64}{2(1)} = \boxed{32m = d_c}$$

c) WHAT IS v_T AT t_{CATCH} FOR $x_{OT} = d_c$?

$$t_{CATCH} = \frac{8 \pm \sqrt{0}}{1} = 8 \text{ SEC FOR } d_c$$

NOTE BOOK

c) CONTINUED

FIND v_T AT $t_c = 8$ SEC

$$v_{Tc} = \cancel{v_{oT}}^{0} + a_{oT} t_c = (1)8 = \boxed{8\ m/s = v_{Tc}}$$

FIND ~~THE~~ AVERAGE SPEED ~~OF~~ THE TRAIN DURING t_c

$$\langle v_T \rangle = \frac{v_{Tc} + v_0}{2} = \frac{8+0}{2} = \boxed{4\ m/s = \langle v_T \rangle}$$